Tappi

JOURNAL OF THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

JULY 1960

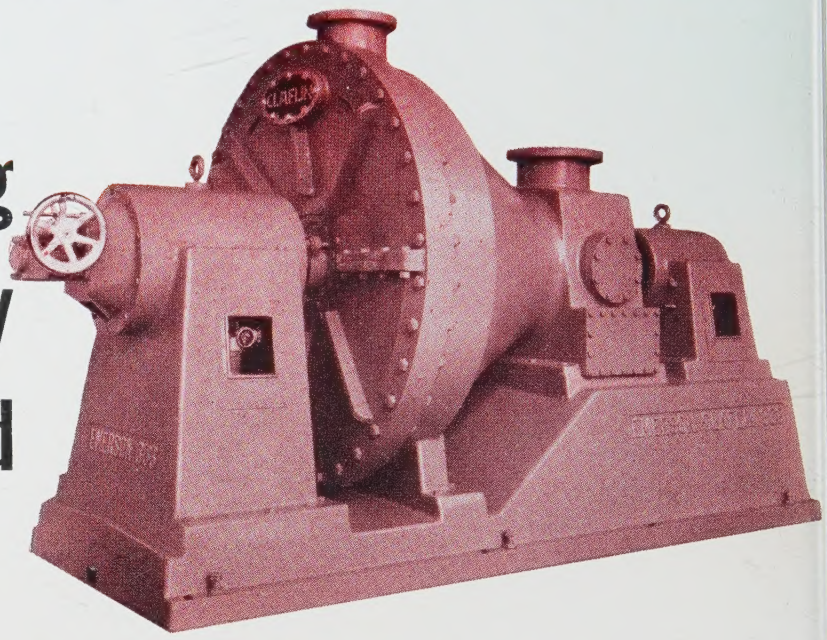
VOLUME 43 • NUMBER 7

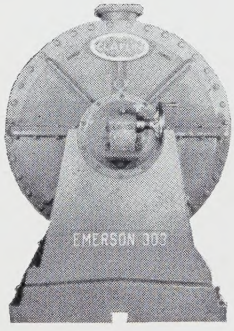
The NEW EMERSON CLAFLIN 303 introduces the very latest advances in refiner engineering and design. For example: the first conical refiner with oil mist atmosphere lubrication system, visual oil and pressure gauges and protective warning system; high gear ratio micro-feed plug adjustment; 100 p.s.i. operating pressure; split head design; all control and inspection areas on one side; and many other features. Each contributes to even greater refining efficiency, operating ease and lower cost maintenance.

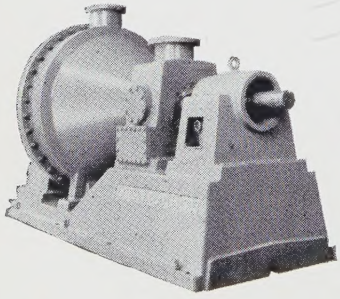
Emerson Claflins serve the Papermaker for more purposes than any other refiner. This exceptional versatility is proven daily in mill after mill where Emerson Claflins are demonstrating their ability to develop the following wide range of fibers with a minimum of freeness drop.

NEW

refining versatility unmatched







Fine Papers — *both soft and hard wood bleached pulp*
Food and Container Board — *both soft and hard wood bleached pulp*
Liner Board — *unbleached Kraft for both base and top sheet*
Bag, Wrap, Multi-Wall, Twisting and Gumming
Folding and Set-up Boxboards — *both filler and liner*
Corrugating Medium — *semi-chemical pulp and waste Kraft*
Wall Board and Roofing Paper
Hot Stock and High Yield — *following blow tank*
Screen Rejects — *fine and coarse groundwood and chemical pulp tailings*

No matter what furnish you are running, or the specifications you have established for finished paper, it will pay you to investigate the versatility and tested refining efficiency of the Emerson Claflin 303 with its sectional hydrating shell and variety of other fillings. Only Emerson makes the Claflin. Write *The Emerson Manufacturing Co., Division of John W. Bolton & Sons Inc., Lawrence, Massachusetts.*

Emerson
CLAFLIN® **303**

A product of BOLTON EMERSON

SHELF TALKER—Alpha® Protein takes the cake at selling it!

The best-selling foods on super-market shelves are those that clamor for attention . . . tempt the shopper by creating the taste-treat right on the package.

How to achieve this full-blown realism on competitively produced coated paperboard? Use Alpha Protein, the chemically isolated soy protein binder. It improves whiteness and brightness, gives the smooth uniform surface needed for fine-screen halftones.

With Alpha Protein in the coating formulation higher solids can be attained, resulting in higher production speeds at reduced costs.

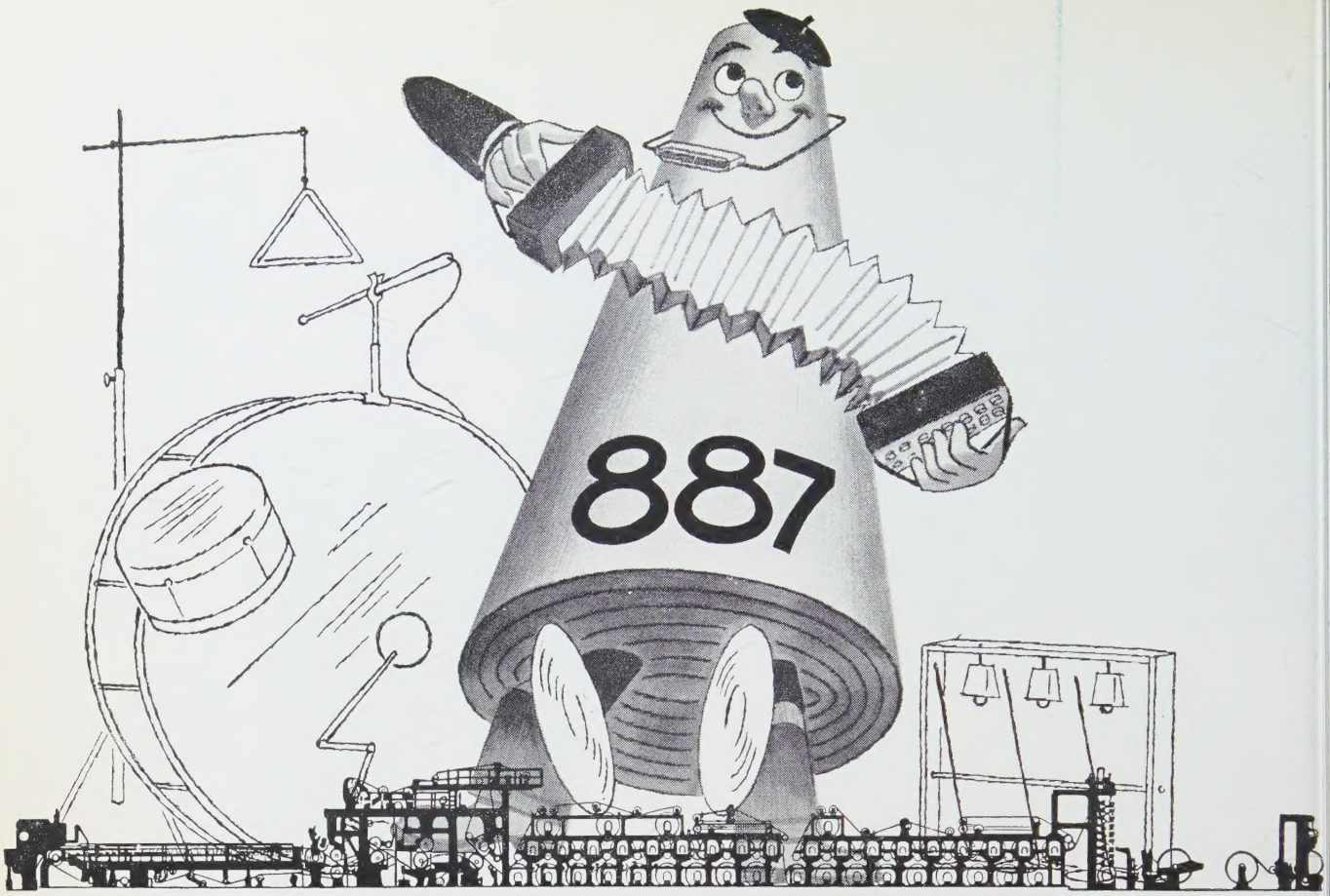
For the newer trailing blade coater, Chemurgy Division offers its Chem-Pro, a specially modified soy protein binder that provides even higher solids.

Chemurgy Division, pioneer in protein coating adhesives, can assure you a uniform high-quality product . . . adequate, on-time shipments . . . stabilized price . . . on-the-spot technical service.

25
YEARS OF CHEMURGY EXPERIENCE

CENTRAL SOYA COMPANY, INC.
CHEMURGY DIVISION
1825 N. Laramie Avenue · Chicago 39, Illinois

This is a sample of 4-color process lithography on Alpha Protein-processed paper



Designed For Greater **VERSATILITY!**

WOODBERRY 887

Asbestos Reinforced Dryer Felt

WOODBERRY 887 is a medium weight cotton dryer felt with asbestos yarns in the face. The asbestos reinforcement provides a higher margin of heat-resistance than can ordinarily be obtained with all-cotton felts. Versatility is another outstanding quality of this reliable felt. Engineered to offer maximum drying and durability, it is ideally suited to a wide variety of drying applications . . . from the making of kraft to light paper toweling production. And no matter where you use it, you can count on the smooth face of WOODBERRY 887 to insure finer finished paper . . . just as you can depend on the high quality of cotton and asbestos composition to provide extended dryer felt life. These many positive advantages of WOODBERRY 887 promote increased production, longer runs with far less downtime. Available pre-stretched and pre-shrunk with or without clipper seams.

MOUNT VERNON DRYER FELT FAMILY – WOODBERRY 887 is just one of Mount Vernon's full "family" of scientifically designed dryer felts. There's an individual felt for virtually every paper machine position and every paper-making need.

Another Mount Vernon Dryer Felt Success Story...

Mount Vernon engineers were consulted by a leading producer of heavy kraft in an effort to find a suitable felt for the second bottom position on their #1 machine. This machine runs at extremely high temperatures and at unusually high speeds in a punishing operation which shortens the life of ordinary dryer felts. Mount Vernon engineers agreed that WOODBERRY 887, asbestos reinforced dryer felt, would do the best job. Result – WOODBERRY 887 ran fourteen weeks versus a competitor's synthetic-cotton run of ten weeks. WOODBERRY 887 lasted as much as 40% longer – cost much less per ton of paper produced.

UNFORMITY Makes The Big Difference In Industrial Fabrics

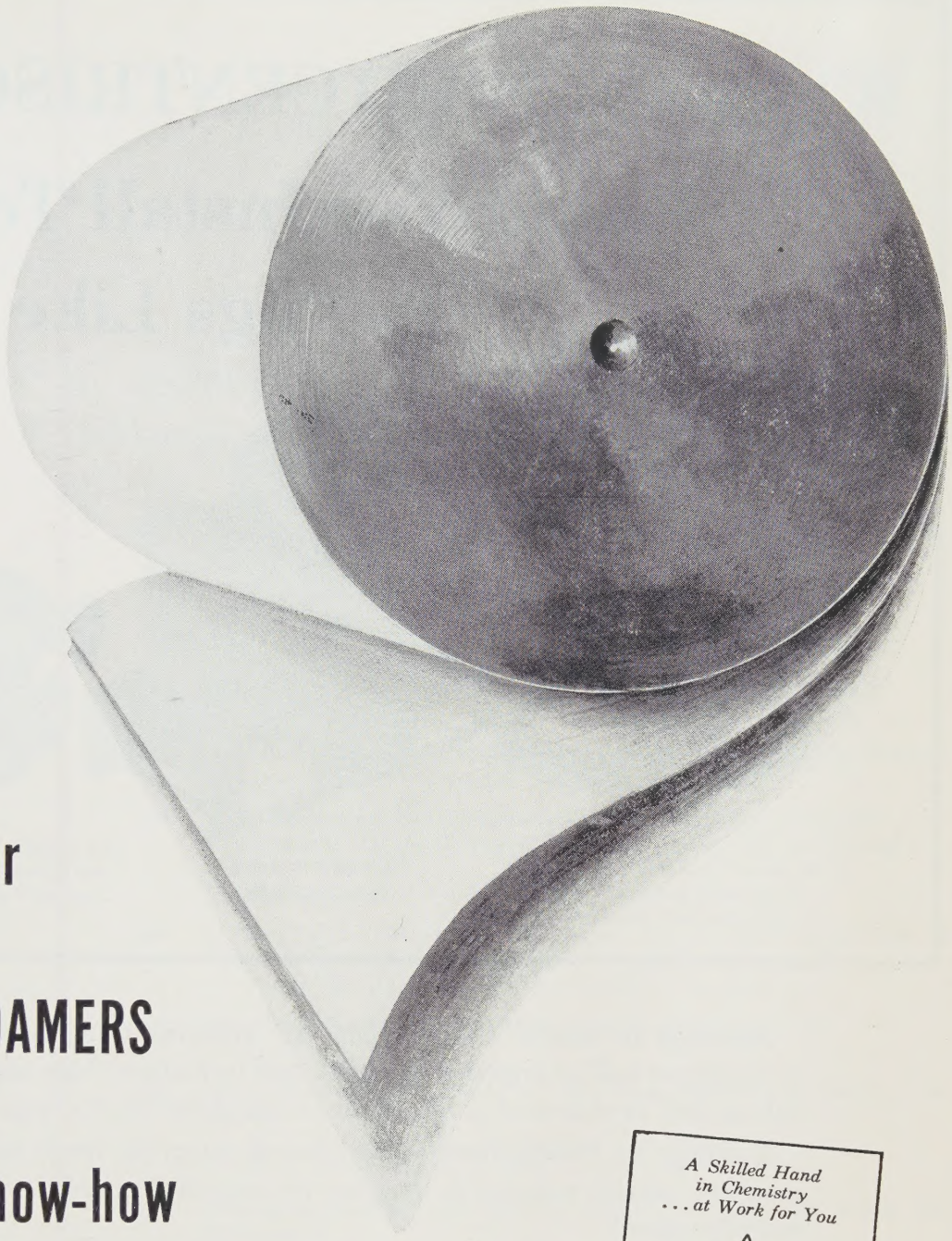
Mount Vernon Mills, inc.

A LEADER IN INDUSTRIAL TEXTILES

TURNER HALSEY COMPANY

SELLING AGENTS

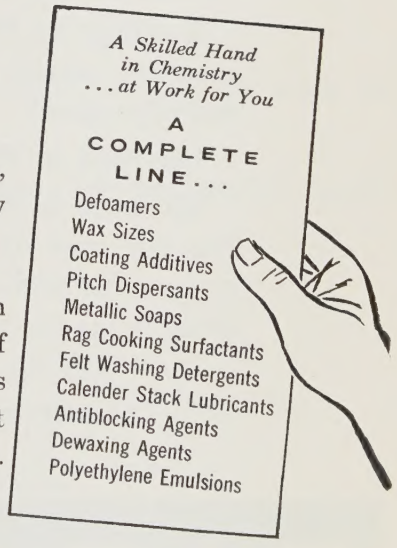
Main Office: 40 Worth Street, New York, N. Y.



make cleaner paper with NOPCO® DEFOAMERS backed by Nopco know-how

One of the causes of a bad run of paper can be foam. Bubbles that carry fiber, size or color on their surface burst and leave light spots. Those that carry filler or dye leave dark spots. Either way, the sheet won't pass inspection.

Many variables contribute to foam formation. Since each mill has its own distinct foaming problems—because of differences in equipment, type of water, chemicals used and running speeds—it takes a wide range of defoamers to meet them all. Let your Nopco specialist work with you to develop the best system for your conditions. Write for specific information and for literature.



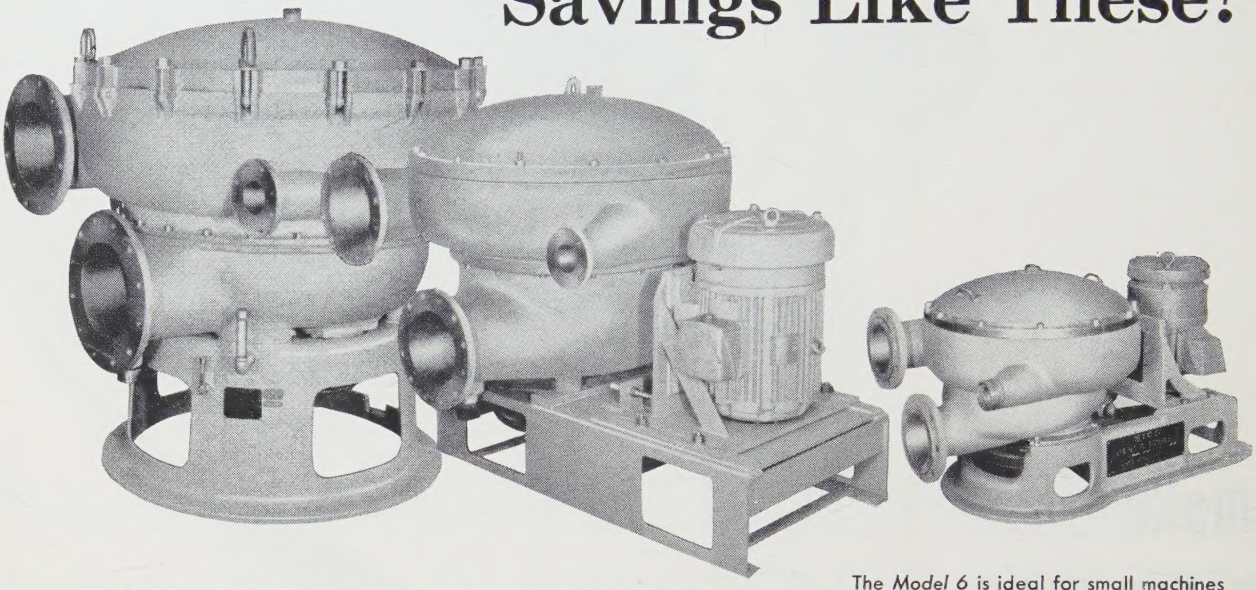
NOPCO®

NOPCO CHEMICAL COMPANY

60 Park Place, Newark, N.J.

Plants: Harrison, N.J. • Richmond, Calif. • Cedartown, Ga. • London, Canada • Mexico • France
Manufacturing Licensees Throughout the World

Which size BIRD CENTRISCREEN Should You Install To Effect Savings Like These?



The *Model 14* Centriscreen delivers up to 6000 gallons of clean, shive-free stock per minute.

The *Model 10* delivers up to 3000 gpm.

The *Model 6* is ideal for small machines and cylinder machines with one screen per vat. Capacity up to 1200 gpm.

Savings in Stock: Centriscreens are effecting substantial reductions in rejects as well as improving quality and formation. This applies to difficult as well as standard grades. Lumps and slime are no longer a problem.

Savings in Production: Centriscreens mean far fewer breaks on the machine, greatly reduced down time and constant operation at maximum machine speed.

Savings in Wire Life.

Savings in Screening Cost: Users are uniformly enthusiastic about the low cost of operating and maintaining their Centriscreens. These screens run and keep on running month in and month out without screen plate breakage or erosion.

Ask us to submit recommendations, layouts and estimates on the right size Centriscreen for your paper machine.

BIRD MACHINE COMPANY

SOUTH WALPOLE, MASS.

REGIONAL OFFICES: EVANSTON, ILLINOIS
PORTLAND, OREGON • ATLANTA 9, GEORGIA

Canadian Manufacturers of Bird Machinery
CANADIAN INGERSOLL-RAND COMPANY, Limited, Montreal

published monthly by the

Technical Association
of the
Pulp and Paper Industry

at 20th and Northampton Streets
Easton, Pennsylvania

Editorial and Advertising Offices:
360 Lexington Avenue
New York 17, New York

EDITORIAL DIRECTOR
R. G. MACDONALD

EDITOR
R. T. BINGHAM

ASSISTANT EDITOR
MICHAEL KOURIS

Tappi is published monthly by the Technical Association of the Pulp and Paper Industry at 20th and Northampton Streets, Easton, Pa. Editorial and advertising offices, 360 Lexington Avenue, New York 17, N. Y. Articles for publication and communications regarding the editorial content of **Tappi** should be addressed to the Editor at the editorial office. Statements and opinions expressed in articles and editorials appearing in **Tappi** are those of the contributors, and the Technical Association of the Pulp and Paper Industry assumes no responsibility for them.

Subscription: U. S. and possessions $10.00; Canadian $11.00; Pan American Union $12.00; Other Foreign $13.00. Single copies to members of TAPPI $1.00; Non members $1.50.

Second-class mail privileges authorized at Easton, Pa. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 27, 1949.

© Copyright 1960, by the Technical Association of the Pulp and Paper Industry. An index of the technical articles appearing in the magazine appears in the Industrial Arts Index and the Engineering Index.

The Technical Articles are in accord with the recommendations of the Division of Pulp, Paper, and Board of the International Union of Pure and Applied Chemistry.

All the publications of the Technical Association of the Pulp and Paper Industry may be obtained from the offices at 360 Lexington Avenue, New York 17, N. Y.

JULY 1960

Vol. 43, Number 7

Tappi

TECHNICAL SECTION

609 **Studies on Slime Accumulations in Pulp and Paper Mills. IV. Fungal Floras of Slime Accumulations**
D. Brewer

611 **Studies on the Chemistry of Aspenwood. VI. Products of Alkaline Hydrolysis of Various Portions of the Aspen Tree**
Irwin A. Pearl and Donald L. Beyer

613 **A Continuous Freeness Recorder for Pulp Suspensions**
D. J. Williams

620 **Rapid Method for Determination of Total Sulfur in Viscose**
J. F. Crow, J. P. Dux, and L. H. Phifer

622 **Xanthate Sulfur Determination by the Batch Ion Exchange Method**
Lyle H. Phifer and Joan L. Bell

626 **The Correlation and Precision of Manometric and Five-Day Biochemical Oxygen Demand in the Range of One to Twenty Parts Per Million**
E. O. Dillingham and A. G. Jose

630 **Studies on the Nitration of *Eucalyptus rostrata*. III. Hydrolysis of Nitrated Wood**
Joseph A. Epstein and Menachem Lewin

634 **The Oxidation of the ICCA Pulps with Lead Tetraacetate**
Richard W. Detrick

639 **High Wet-Strength Paper by Wet-End Addition of Dialdehyde Starch**
B. T. Hofreiter, G. E. Hamerstrand, C. L. Mehltretter, W. E. Schulze, and A. J. Ernst

643 **Sweetgum Sulfate and Neutral Sulfite Semichemical Pulps for Linerboard**
D. J. Fahey and V. C. Setterholm

650 **On the Biosynthesis of Gymnospermae and Angiospermae Lignins**
K. Kratzl

654 **Clarification of High Color Waters**
C. T. Wise

657 **Cord Fatigue in Fleet Tested Tires**
W. G. Klein, M. M. Platt, and W. J. Hamburger

665 **A Measure of Surface Tension and Surface Film Elongation**
P. B. Davidson

668 **Rapid Melting-Point Method for Waxes**
Donald C. Walker

669 **Water Conservation by External Re-Use**
L. L. Klinger

CONTENTS CONTINUED ON NEXT PAGE

Tappi

JULY CONTENTS — *continued*

PRESIDENT

J. R. LIENTZ
Union Bag-Camp Paper Corp.
Savannah, Ga.

VICE-PRESIDENT

H. M. ANNIS
Oxford Paper Co.
230 Park Ave., New York 17, N. Y.

EXECUTIVE-SECRETARY

P. E. NETHERCUT

TREASURER

R. G. MACDONALD
Technical Association of the Pulp and Paper Industry
360 Lexington Ave.
New York 17, N. Y.

PUBLICATIONS MANAGEMENT COMMITTEE

H. M. ANNIS
W. C. BLOOMQUIST
F. P. DOANE, JR.
J. J. KOENIG
J. M. MCEWEN

EDITORIAL BOARD

R. M. K. COBB
J. W. CROCKER
W. R. CSELLAK
J. M. FETSKO
A. LEWENSTEIN
E. H. OLMSTEAD
K. D. RUNNING
E. R. SCHAFER
M. S. KANTROWITZ
R. C. MASTERMAN
J. G. PATRICK
J. R. SANBORN
F. R. SHELDON
H. A. SPENCER
R. S. VON HAZMBURG
C. B. CHRISTIANSEN
J. W. GILBERT
E. G. LOCKE
G. G. MALTENFORT
M. N. MAY
R. H. MOSHER
J. F. THERIAULT
J. WEINER

ASSOCIATION SECTION

14A **Corporations are People**, *David H. Dawson*
24A **Data on the Reaction-Increasing Action of Sodium Aluminate on Titanium Dioxide and Other Fillers in the Manufacture of Paper**, *G. Rieck and O. Huber*
87A **Association News and Events**
104A **TAPPI Notes**
104A The TAPPI Yearbook, *James W. Field*
106A **TAPPI Profiles**, John M. McEwen
108A **Personal Mention**
112A **Industrial Notes**
112A North American
112A Overseas
113A Pulp and Paper Manufacturers and Converters
115A Educational Institutions
116A Industry Suppliers
120A General
122A **Obituary**
123A **Engineering Division**
123A Questions and Answers
125A Economic Aspects of Pressures and Temperatures for Pulp and Paper Mill Power Plants
125A Economic Aspects of Pressure and Temperature as They Relate to Turbine Generators, *I. H. Landes*
127A Economic Aspects of Pressures and Temperatures for Pulp and Paper Mill Power Plants as Related to Power Boilers, *H. B. Wallace, Jr.*
128A Economic Aspects of Pressure and Temperature as They Relate to Chemical Recovery Units, *F. W. Hochmuth and W. J. Darmstadt*
130A Economic Aspects of Pressure and Temperature as They Relate to Mill Operation, *T. J. Judge*
133A **TAPPI Standards**
133A Chlorine Consumption of Pulp
Proposed Revision of TAPPI Standard T 202 m-45
136A **Routine Control Methods**
136A RC-281. Rapid Identification of Wet-Strength Resins
136A RC-282. Repulpability of Splices
137A **TAPPI Data Sheets**
137A Roll Storage Capacities and Floor Loading, TAPPI Data Sheet 203
139A Flow Process Symbols, TAPPI Data Sheet 204
141A **Local Section Activities**
141A Meeting Calendar
141A Italian
142A St. Louis
143A Ohio
144A Southeastern
144A Use of Titanium Equipment in Chlorine Dioxide Bleaching, *Henry B. Meier*
146A Pacific
147A Pacific TAPPI-CPPA
147A Empire State (Eastern District)
147A Empire State (Metropolitan District)
147A The Next Challenge—Impermeable Cartons, *Robert J. Kelsey*
149A Lake Erie
149A One Road to More Efficient Packaging and Package Making Operations, *William Schoenberg*
151A Mill Testing of Boxboard for Folding Carton Usage, *C. G. Eckhart*
152A Testing Board for Coating and Testing Coated Board for Folding Carton Manufacture, *Ivan L. Lester*

154A Testing Boxboard for Folding Carton Fabrication and Testing Folding Cartons for Packaging and End-Use Performance, *Robert O. Ragan*
157A The Problems We Experience with Folding Cartons, *W. W. Adams*
159A Testing Folding Cartons for Packaging Machine Performance and Testing Filled Packages for End Use, *Howard N. Nelson*
161A The Customer and Corrugated Box Testing. Introduction to Corrugated Box Panel, *Leo M. Monroe*
162A Mill Testing of Corrugating Medium and Liner for the Fabrication and End Usage, *Peter A. Illing*
163A End-Use Testing of Corrugated Board and Boxes, *C. A. Sullivan*
164A Some Problems Encountered in the End Use Testing of Corrugated Boxes, *Earl B. Candell*
167A The Problems We Experience with Corrugated Boxes, *Burton Williams*
170A **Employment Service**
172A **Papers Presented at the Corrugated Containers Sessions, and Discussion; 45th Annual Meeting**
172A Supervisory Practices in Container Plants, *R. W. Buttery*
173A Unitizing of Corrugated Containers, *John A. Comly*
177A Operating Experiences with Tapered Mechanical Glue Roll Drives, *Robert A. Sherman*
179A Scheduling a Container Plant, *Roy P. Caponi*
182A Product Development and the Production Merry-Go-Round, *H. J. Schlotter*
183A New Methods for Production Control of Colloidal Silica Antislip Applications on Corrugators, *Burt Mendlin and H. J. Wilhoyte, Jr.*
187A Production, Progress, and the Manufacturer's Joint, *Jerome J. Kipnees*
189A Sources of Errors and Practices Contributing to Their Reduction, *W. J. Hurrell*
193A Session III, Proceedings
201A **Letters to the Editor**
201A Failure of Titanium in Dry Chlorine, *F. G. Hawks, Jr., and H. G. Taylor*
202A **The Philadelphia Conference of the Graphic Arts Industry**
202A (Delaware Valley Local Section Meeting, March 26)
203A Web Offset Printing, *Bernard Green*
205A A Papermaker Takes a Look at the Web-Fed Offset Press, *M. M. Muntz*
206A Web Offset Inks, *Ludwig P. Horn*
207A Gloss Inks, *John Moody*
208A Gloss Ink Printing, *Dan O'Connor*
209A Paper for Gloss Ink Printing, *Joseph Abelson*
210A Surface Coatings with Improved Printability, *John O'Donnell*
212A Paper Surface Characteristics from a Printers Point of View, *Robert Headly*
213A The Influence of Paper Surface Characteristics on Printing Inks and Their Formulation, *Joseph Krause*
214A New Developments in Graphic Arts, *A. E. Sterner*
215A The Screen Process, *Herb Sperry*
216A The Chemical Industries Contribution to Improved Utilization of Wood *Donald V. Redfern*
217A Some Aspects Involved in Refining High Yield Pulps and Reject Pulps, *John T. Henderson*
218A Availability and Use of Wood for Pulp in the Pacific Northwest, *John B. Grantham*
221A The Sandy Hill Rotoformer, *G. E. Clink*
224A **Papers of Current Interest**
224A Process Control as Related to Fourdrinier Operations, *Roger L. Traxler*
226A Refiner Bleaching of Cold Caustic Pulp, *J. F. Jahne and C. E. Price*
228A A Review of Corrosion Problems in Neutral Sulfite Semichemical Pulping, *E. K. Scholz and L. H. Park*
230A A Proposed Test for Abrasiveness of Pigments and Paper Fillers, *R. D. Fraik and F. C. Schmutz*
233A Equitable Allocation of Costs for Process Steam and Electric Power in Pulp and Paper Mills, *Glenn D. Farrar*
238A Purified Egyptian and Syrian Cotton Linters of Low Ash and Silica, *M. Omar, M. A. El-Taraboulsi, and M. Sheriff*
240A Use of Titanium in Pulp Bleaching Equipment, *G. W. Bauer*
241A A Practical Approach to Open Side Calender Design, *Joseph E. Perkins*
242A Rope Carrier Practices, *H. H. Mullins*
244A Determination of Pentosans in Chemical Wood Pulps, *I. Grobelny and W. Illukowicz*
247A **Index to Advertisers**

COMING EVENTS:

Calendar of National Conferences

Fourteenth Alkaline Pulping Conference
Multnomah Hotel, Portland, Ore.
Aug. 22–24, 1960.

Forest Biology Conference
Seattle, Wash.
Aug. 24–27, 1960.

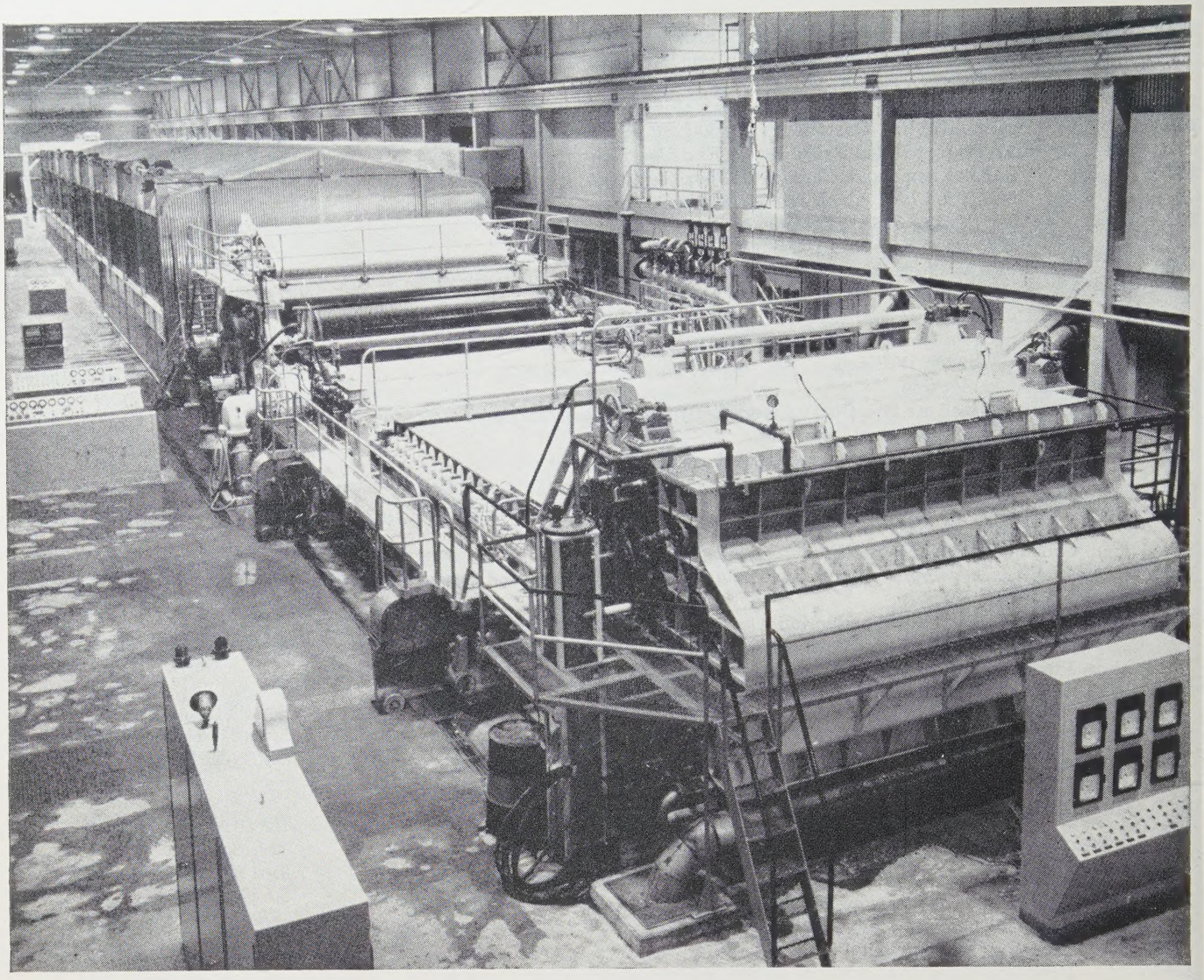
Eleventh Testing Conference
Pantlind Hotel, Grand Rapids, Mich.
Sept. 27–29, 1960.

Tenth Corrugated Containers Conference
Royal York Hotel, Toronto, Ont.
Oct. 10–13, 1960.

Fifteenth Plastics-Paper Conference
Hotel Syracuse, Syracuse, N. Y.
Oct. 17–19, 1960.

Fifteenth Engineering Conference
Robert Meyer Hotel, Jacksonville, Fla.
Oct. 24–28, 1960.

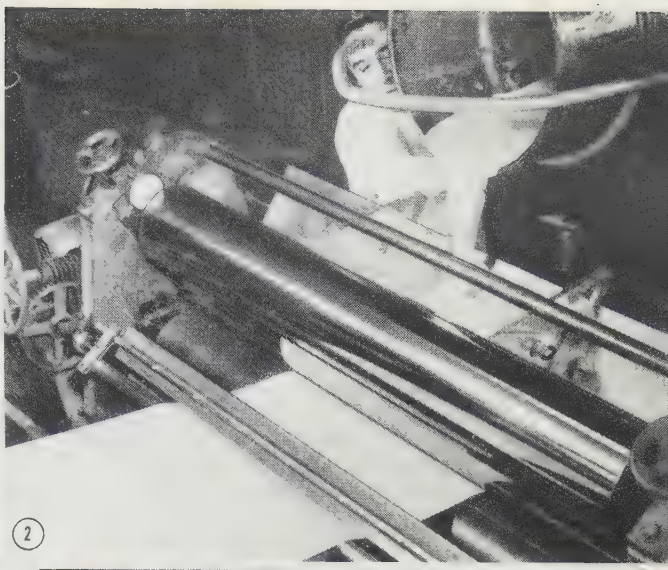
Please refer to Local Section Activities for the locations and dates of Section meetings

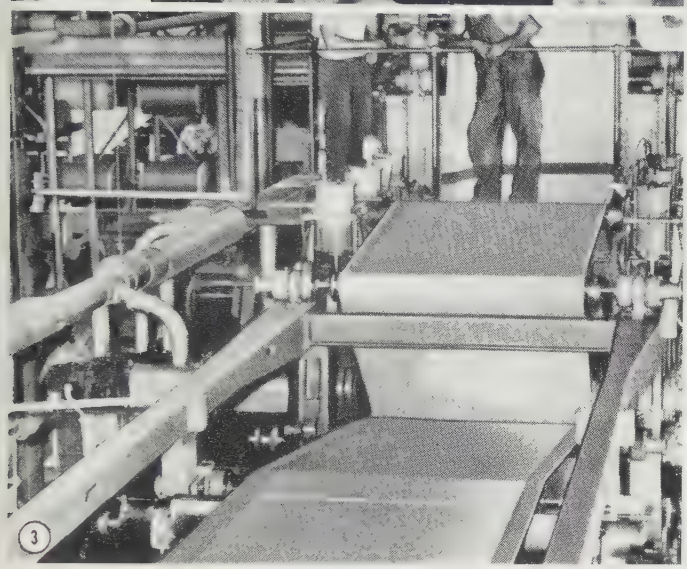


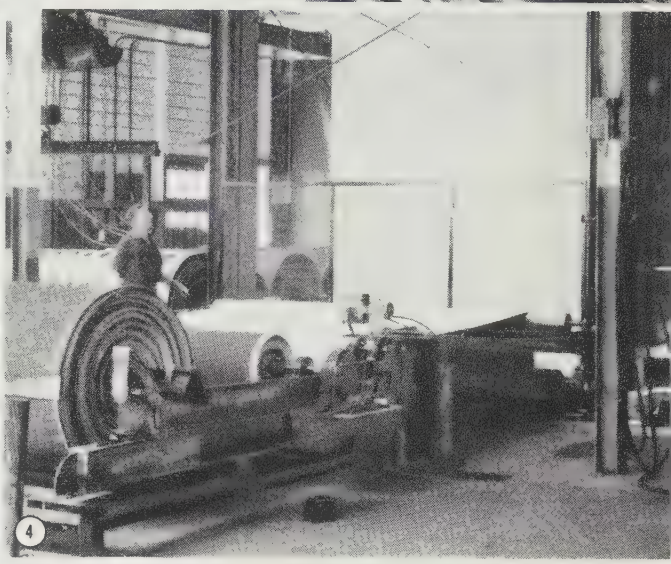
#6 Fine Paper Machine
at Howard Smith-Cornwall was
built by Dominion Engineering and
installed in record time.

It incorporates many
new design features.

PAPER DIVISION
DOMINION ENGINEERING
COMPANY LIMITED
MONTREAL • TORONTO • VANCOUVER





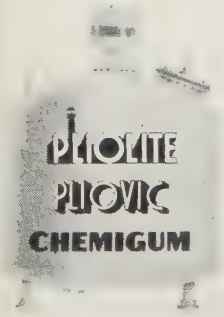


They're getting profit ideas on paper with Goodyear latices

Big news-makers in the paper industry are the special products being developed to do special jobs. Like making a stronger, more oil-resistant gasket. (1) Or toughening up tape. (2) Or making dielectric sheets more solvent-resistant. (3) Or printing full-color flooring patterns 100 times sharper. (4) And to do these jobs, paper manufacturers are turning to Goodyear latices.

Want to give your paper improved body, drape, strength and dimensional stability—greater flexibility and softness—outstanding resistance to wear and aging? Then Goodyear latex is the answer.

To simplify selecting them, Goodyear offers four basic types: PLIOLITE *Latex* in two forms (as a rubber or resin dispersion), PLIOVIC *Latex* (dispersion of vinyl copolymer resin), and CHEMIGUM *Latex* (dispersion of nitrile rubber). Each can be used alone—in combination with another—or as a modifier in your present materials. For the finest in technical help on latices, including the latest *Tech Book Bulletins,* write Goodyear, Chemical Division, Dept. S-9432, Akron 16, Ohio.



Lots of good things come from

GOODYEAR

CHEMICAL DIVISION

Chemigum, Pliolite, Pliovic—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

FOR IMMEDIATE DELIVERY

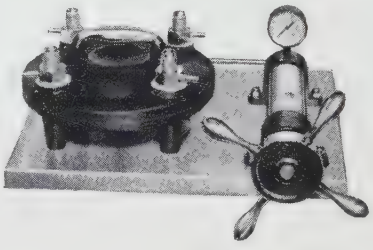
Tappi Standard

Pulp Testing and Sheet Making Apparatus

TAPPI SHEET MAKING MACHINE

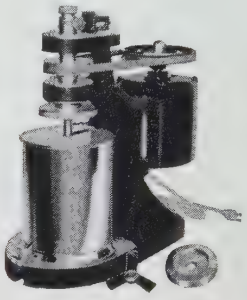
Bronze, brass and stainless construction throughout except couch roll which is heavily chrome plated. Drying Rings with gaskets and Drying Discs available but not illustrated. (T-205 m)

TAPPI PUMP & PRESS



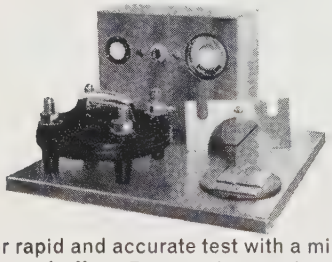
Mounted on 18-8 Stainless steel base. Press on base, or pump only may be purchased separately. (T-205 m)

TAPPI DISINTEGRATOR



Standard equipped with bronze chromium plated container bowl and stainless steel chuck, collet and shaft assembly. (T-205 m)

TAPPI PRESS WITH AUTOMATIC CONTROL

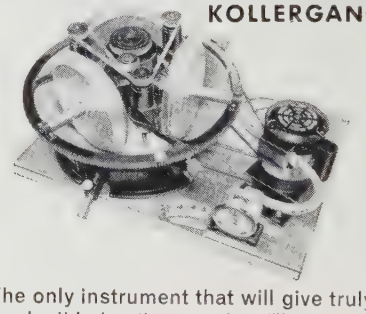


For rapid and accurate test with a minimum of effort. Base and control cabinet 18-8 stainless steel.

AUTOMATIC COUCHING DEVICE FOR SHEET MACHINE and FIBER LENGTH CLASSIFICATION GRID PLATE

(Not illustrated)

IMPROVED PRECISION KOLLERGANG



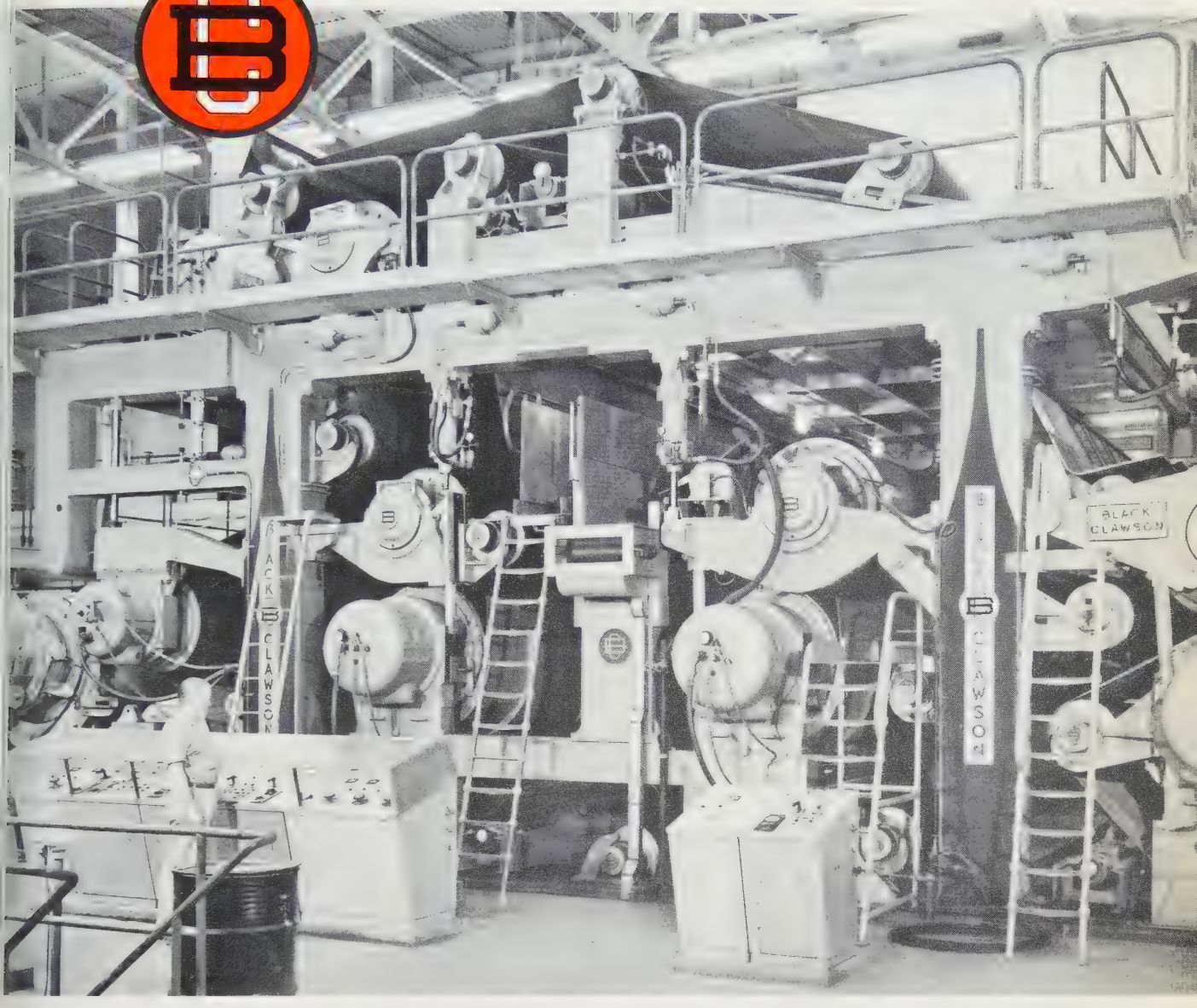
The only instrument that will give truly reproducible beating results. (T-225 sm)

This line of equipment features the ultimate in pulp testing and sheet making apparatus. Latest improved corrosion resistant material is used on all parts coming into contact with pulp solutions used in testing. The operational precision, durability and beautiful finish will command greater laboratory efficiency and cleanliness. All the Tappi Standard approved apparatus also bears the official seal and registered serial number of the Papermakers Association of Great Britain and Ireland.

HERMANN MANUFACTURING CO.

LANCASTER, OHIO

Have You Ever Seen *a cleaner, more business-like press section?*



It's cleaner in design, uncluttered, easier to operate and maintain because it's been simplified. There's a minimum of parts. Roll removal is an easy procedure . . . so is felting, because all components are accessible.

When engineering paper machine sections, Black-Clawson strives for greater efficiency through design simplification.

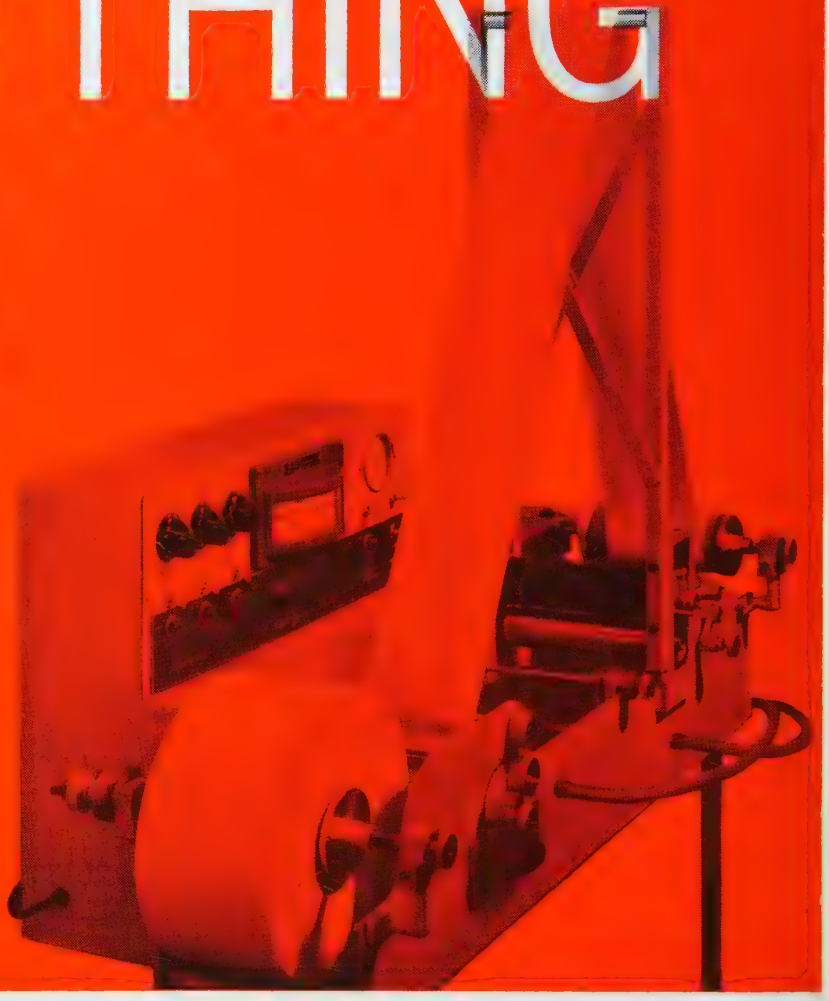
The customer is always the beneficiary of advanced paper machine engineering that is based on practical understanding of the papermaker's needs.

The Black-Clawson Company
Paper Machine Division, Watertown, N. Y.

Another Advanced Engineering Design

BLACK-CLAWSON

ANYTHING YOU CAN DO WE CAN DO SMALLER



WHEN IT COMES TO TESTING PARAFFIN COATINGS FOR ANY SPECIALIZED NEED

The table-size model pictured here is really a *complete* wax-coating machine. With this and our other lab equipment, Atlantic technicians can match conditions you'll encounter when you're coating paper stock with paraffin for any commercial purpose. This is possible because every factor present in wax-coating operations also is present and can be carefully controlled on these ingenious testing devices.

First, Atlantic researchers check the wax temperature, paper speed and chilling bath to make sure they agree exactly with the information you've furnished our Sales Engineer. Then they determine by informed experimentation the proper waxes required for seal strength, moisture resistance, blocking, slipping or whatever characteristics are necessary to solve a specific paraffin coating problem.

This paper-coating machine is typical of the testing equipment used in the Atlantic Research Department to assist you in serving your customers. Others include our exclusive Imflex Tester for determining impact resistance and flexibility . . . the Seal Strength Tester which measures the force-per-inch necessary to separate wax paper laminations and seals . . . and tests for gloss, resistance to grease and for finding the coefficient of friction on waxed surfaces.

Your Atlantic Sales Engineer will be happy to assist you in solving your wax-coating problems. His years of specialized experience should prove invaluable in helping you select the paraffin blends best suited for your own requirements. And his on-the-spot technical assistance is backed by the complete facilities of the Atlantic Research Department.

ATLANTIC

CHOOSE FROM OUR FULL RANGE OF HIGH-QUALITY WAXES TO MEET YOUR PAPER-COATING NEEDS

Philadelphia, Pa. • Providence, R.I. • Syracuse, N.Y. • Pittsburgh, Pa. • Charlotte, N.C.

DOW | SARAN LINED PIPE

Saran Lined Pipe carries 140° F. Sulphuric Acid . . . resists shock, temperature changes, corrosion

When a leading paper manufacturer needed a dependable pipeline to carry hot, strong acid waste from its chlorine dioxide bleach plant to a distant kraft recovery system . . . when the pipe had to withstand severe thermal shock, and require a minimum of support and maintenance . . . Saran Lined Pipe was specified as the best answer on all counts.

The Nekoosa, Wisconsin, plant of Nekoosa-Edwards Paper Company installed the chlorine dioxide bleach plant two years ago. Acid waste from the reactor consists of sodium bisulfate dissolved in 35% concentration sulphuric acid. This highly reactive solution enters the Saran Lined Pipe system at 140° F., to be carried to the kraft pulp mill recovery system where both sulphur and sodium are ultimately recovered. The pipeline traverses work areas and pipe tunnels, often being inaccessible for repair and maintenance, and in places is exposed to outside temperatures which can range well below zero in winter.

Because of its extreme corrosion resistance and high physical strength . . . despite conditions of high chemical reactivity, and of thermal and physical shock . . . Saran Lined Pipe continues to perform well for Nekoosa-Edwards, providing completely dependable, maintenance-free performance.

Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can easily be cut, fitted and modified in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 2287FC7.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

Corporations Are People

DAVID H. DAWSON

I AM deeply appreciative of the honor of being invited to join this meeting of the National Association of Printing Ink Makers, and to open your discussion of personnel relations. Modesty should have forced me to urge that you seek the services of one more expert in this field. I am reassured, however, by the fact that in my company, at least, it seems to be the one area where we all consider ourselves to be experts, and bow not to the judgment of others.

Perhaps this is the explanation for the amazing proliferation of books and magazines and of research studies in this field of personnel relations and administration. It seemed to me to reach some sort of a peak when there recently came to my desk a publication of the National Industrial Conference Board—No. 175 in its Studies of Personnel Policy. It was devoted only to "Forms and Records in Personnel Administration," and comprised no less than 384 pages.

The reason for the extraordinary growth and extent of such studies is not difficult to find. Basically, I believe it reflects the recognition that corporations are people. They are, of course, more than that—they are legal entities; they are aggregations of capital, such as money in the bank and money invested in inventories and manufacturing plants; they develop "images" in the public mind; they become associated with their history and their products; and they continue to exist when some of their people die or retire. But in the final analysis, they are voluntary associations of people, and their accomplishments are the sum of the accomplishments of their people—past as well as present.

All of these people contribute to the extent that they are willing and able, and some contributions are more important than others. There are cases where the vision, the drive, or the ideas of a single individual may be the biggest factor in the success of a corporation. It may even be that an individual in the past contributed so much that a corporation keeps progressing on the momentum of his efforts. But over the long period, the future accomplishments of the corporation will be no more than the future accomplishments of all its people.

There is a growing tendency to think of corporations, and particularly big corporations, in a depersonalized sense—to attribute to them powers and motives of their own, disassociated from the people who build and guide the power and supply the motives. Thus, we have voices crying—like that of A. A. Berle—that we have "Power Without Property," and that there are dangers lurking in the diffused ownership of the modern corporation, and in the claimed ability of management to determine corporate policy in the absence of the responsibility of ownership. Close association of ownership and management is of great value, but it is secondary to the total impact of the corporation's people, who must act with full recognition of all its obligations—to the owners of the business, to its customers, to its employees, and to the public.

If, then, we can agree that a business enterprise can exist in any real sense only by virtue of its people, we would be well advised to give the most careful thought to the problems associated with these people—how do we get them, how do we use them, how do we keep them—preferably satisfied, necessarily effective.

This, of course, is a subject of great breadth, not to be lightly approached in a 20-min. talk. I gather you will be at it for most of two days. All I can hope to do is to treat it most generally, but hopefully with emphasis on the more basic considerations.

Even so, I would like to limit my discussion in its more specific terms to those of the company's people who perform managerial, supervisory, technical, and administrative duties. This is not to minimize the contributions of other groups nor the problems involved in dealing with them; nor is it meant to imply that similar considerations are not frequently applicable to them. But it does give us a segment of the problem which can be more easily handled, and one which is usually the more critical in determining a company's future accomplishments.

While many of my points of view reflect the experience of a large corporation, I would think they are, for the most part, applicable as well to smaller aggregates of people. We must obviously reach a point, as size declines, where some, at least, would no longer have validity.

Let us turn now to the first of our three problems of getting, using, and keeping people. Parenthetically, I might add that it seems strange that so much of the literature in this field is devoted to using and keeping people, when it is obvious that if you don't get the right ones, you shouldn't worry about keeping them, while using them properly may not be worth the large effort required.

I suspect one reason this phase gets less attention is that it is so far removed from top management's sphere of activities. The president, of course, can't be expected to interview every new salesman or chemist, but on the other hand, the recruiting, interviewing, and hiring of new people should not be treated as a mechanical operation properly delegated to ill-equipped clerical personnel, who are not fully conversant with the work for which the person is being hired.

As a minimum, each applicant should have an opportunity to talk to, and to be heard by, his prospective boss, and that boss's boss, and perhaps a step higher in the corporate structure. Time consuming? Yes, but well worth the effort.

There is difficulty, of course, in recognizing and selecting good performers, and increasing use is being made of testing devices. Although these are doubtless

DAVID H. DAWSON, Vice-President, E. I. du Pont de Nemours & Co.

Merfenel 51*®

*PACKED IN ONE AND TWO OUNCE ENVELOPES

A Tested Product

FOR
SLIME CONTROL
•
MOLD PROOFING
•
PRESERVATION OF
STARCHES AND PROTEINS

R. T. VANDERBILT CO. INC.

230 Park Avenue, New York 17, N. Y.

suitable for some applications, we set greater store on the evaluation of past accomplishment, and even more on thorough interviewing by people fully conversant with the work a man is expected to do—not only initially, but looking a reasonable time ahead, and with the company's future needs for people in mind.

We have reached the obvious conclusion that individual capacity and inclination are more important than education and training. We feel, nonetheless, that good basic training gives a man a better start and, other things being equal, is apt to result in the more productive employee. In the chemical industry, we have a strong predilection for training along engineering or scientific lines.

An improvement in the quality of the people we get might be achieved if we were able to concentrate our hiring in periods of lesser business activity and consequent lower demand. Even in recent years, when engineering and scientific personnel have been in short supply, demand has fluctuated widely, and it is quite clear that in the years of lower demand, we have been able to hire better qualified and more able people. Unfortunately, we hire fewer, and defer our program to the following year, by which time everyone else is doing the same thing. We may well get more people, but on the average we also get less able ones. This problem, like that of spending for new plants when construction is at low ebb, is not easily solved, but its solution would bring large rewards.

The problem of using the people we get for the greatest good of the business is complex. It becomes almost synonymous with the whole field of corporate management. But in the final analysis, the objective is simple and straightforward. It is to utilize the widely varying skills of each individual to the maximum capacity which he is able to fulfill and willing to undertake, and in capacities to which he is most uniquely suited.

This requires, first, a willingness and a desire on the part of management to keep a man in a given job for a relatively short time—only as long, in fact, as proves necessary for him to show that he has mastered it and is capable of broader and more demanding responsibilities. In a larger organization, this will involve frequent changes in location, with some temporary disadvantages to the organization, as well as to the man. It acts to prevent our younger people striking deep roots in the communities where our plants are located, and may at times present family and adjustment problems.

But there are offsetting advantages. The employee has the stimulation of new problems and responsibilities, and the opportunity to obtain a wider view of the company's operations. For the company, it serves to guard against ingrown and inbred local organizations, and to allow employees to be appraised periodically by different individuals under different working conditions, and hence for it to obtain a sounder measure of a man's capacity.

The practice of such a scheme of job rotation should not be limited to a given sphere of activity, such as sales, manufacturing, research, or financial control. Although the risks are greater, and temporary loss of efficiency may be greater, there are advantages in shifting people to different fields. One is obvious—at some point in a man's potential career, knowledge of the operation in breadth as well as in depth will be essential; at all levels it is helpful. Temporary training and staff assignments are alternative methods, but these are not adequate substitutes for the experience obtained with full responsibility for various segments of the business.

Of equal importance is the insight which is obtained into the man's ability to adjust—and into the rate of his adjustment to radically different responsibility. When such insight is obtained relatively early in a man's career, it is possible to forecast with more assurance his ability to progress to broad management responsibility. It must be granted that mistakes will be made, and that their correction will be difficult. But in the long run, the mistakes are no more frequent, and generally of lesser impact, than those that inevitably occur at times in the promotion of men, experienced in only one field, to managerial jobs demanding knowledge of several.

This practice of job rotation among functions, sometimes referred to as "cross-fertilization," should preferably start with minimum changes. A promising research man believed to have greater potential in sales work might first be transferred to technical sales service rather than directly to sales. Once a man has successfully demonstrated his ability to adjust—and very importantly, to adjust quickly—more drastic changes can be made with confidence.

It is clear that this technique involves experimentation, and in all experiments that are worth trying, there will be failures. Consequently, the scheme should not

ew treatment gives super high gloss
packages coated with A-C Polyethylene

ew heat treatment using A-C® Polyethylene eloped by Semet-Solvay imparts *super* high ss to waxed paperboard . . . lets you dispense h overwrapping in many cases. It's ideal for zen food and ice cream packages . . . butter l oleo . . . bread wrappers.

You can use this new technique while realizing all the advantages of A-C Polyethylene wax coatings: greater resistance to grease, moisture, scuffing and abrasion . . . smooth plastic-like feel . . . positive lock at freezing temperatures . . . brighter printing effects.

For details on *super* high gloss with A-C Polyethylene, write us at the address below.

Allied Chemical

SEMET-SOLVAY PETROCHEMICAL DIVISION

Dept. 576-E, 40 Rector Street, New York 6, N. Y.

National Distribution • Warehousing in Principal Cities

TC
TENNESSEE CORPORATION

LIQUID SULFUR DIOXIDE

For Removal of
RESIDUAL CHLORINE

A most efficient and economical antichlor—Removes residual chlorine and other materials which cause color reversion or yellowing with age—TC Liquid Sulfur Dioxide also eliminates excessive residual chlorine in water—a product of highest purity.

Available in:
CYLINDERS
TON DRUMS
TANK TRUCKS
TANK CARS

We would like to discuss with you the possibilities of this versatile chemical in your processing.

For more information see our inserts—
Chemical Week Buyers Guide Pages 173-176
Chemical Materials Catalog Pages 551-554

TC TENNESSEE CORPORATION
612-629 Grant Building, Atlanta 3, Georgia

be used unless there is a willingness to deal with and to correct the failures. The fairest thing would seem to be to move the man back to the last job he handled successfully, and from which he was promoted. Preferably, this should be a comparable job but in different surroundings. This is not always possible, and at times it may be necessary to resort to other expedients. While the pains incident to such reassignments are sufficient to inject a necessary note of caution into the organization, they should not be allowed to force it into living too long with unsatisfactory performance, nor to discourage the continuation of the practice of job rotation.

Failures seem to be associated particularly with cases involving a radical change in function together with a sharp increase in responsibility, and usually with cases where the first such change has been made relatively late in a man's career. Hence the argument for its early use.

It may be claimed that a rapidly growing organization is essential to such a scheme, and this is indeed very helpful. Even in relatively static organizations, however, job rotation will be found practical if opportunities are persistently and aggressively pursued. The limitations are more often self-imposed than inherent—even in a declining organization structure. And sometimes, the practice may even assist in halting a decline.

When job rotation is practiced, as in all phases of the problem of effective use of people, there is a large premium to be gained by careful study of each individual. Periodic appraisals of some sort are essential. Rating forms are almost infinite in variety, and I hold no brief for any particular one, or in fact, for the use of any form. There is some risk of getting lost in forms and devices which, however valuable, are merely tools and will have limited value if they are permitted to obscure objectives and basic considerations.

What is important is to make sure that periodically, and certainly at least annually, each individual is appraised, particularly from the point of view of performance—accomplishments versus opportunities. Preferably, the performance should be further analyzed into its elements of strength and weakness. Preferably also, the individual should be studied to determine what he can reasonably be expected to do in the future, whether he is capable of greater responsibilities than he now bears, and whether his strengths could be better utilized by a change in work assignment. Such appraisals need to be made by at least one other individual in addition to the immediate supervisor, in order to protect against bias and blind spots. Finally, to be of greatest value, the appraisal should be reviewed with the individual himself, in order that he may know where he stands, and that he may have the opportunity and encouragement to seek his most useful and effective sphere.

The huge files of appraisals and performance reviews that are accumulated can be most useful as the basis of planning for future action. One end use is in building overall composite pictures of personnel inventories versus needs. Here, too, the devices can get top-heavy and become hardly worth the effort. But personnel inventories, properly used, can be very helpful in showing the need for shifting personnel within the

METASOL

SLIME CONTROL ENGINEERING

Scientific slime control methods now available

METASOL *microbiologist prepares petri dish test to determine micro-organism count of white water.*

New METASOL Krylate Spray keeps surfaces slime-free for extended periods

A new METASOL slimicide product, METASOL Krylate Spray, is another weapon in furthering the effectiveness of a slime control program. When applied to wood, ceramic, concrete and steel surfaces, METASOL Krylate forms a slime-resistant, water-resistant film which keeps these surfaces slime-free for months.

METASOL Krylate is packed in pressurized aerosol containers and sprayed on the desired surface by means of a spray nozzle. Its principal use is on suction boxes, doctor blades and similar inaccessible areas which cannot be cleaned regularly.

Used in conjunction with METASOL Slimicide, METASOL Krylate provides an effective and lethal one-two punch to slime-producing organisms.

A word about METASOL Slimicides

METASOL Slimicides were developed after 7 years of intensive testing and evaluation of almost 2,000 slimicidal products. Chemically, they have a unique di-phenylmercuric ammonium propionate structure. Their special advantages are: high, fast solubility in water; minimum deactivation; rapid initial kill and sustained killing action. They also do not allow resistant organisms to form. METASOL Slimicides will not impart color or odors to the paper. Available in either solid or liquid form, METASOL Slimicides have produced outstanding results in effective slime prevention.

Microbiological and chemical analyses show the way

Microbiological slime is a constant, persistent enemy to paper mills. In fact, many mill men are resigned to the fact that they will always have a slime condition and that the only way to achieve reasonable control is by constant trial-and-error experimentations with different slimicides. While understandable, this attitude can be costly and uneconomical when measured in terms of slimicide cost, quality variations and down time.

Importance of Scientific Analysis

The point is, effective slime control is possible if the problem is approached with scientific exactness. The source and type of infection must be properly identified. Then a formal program must be developed which details proper slimicide treatment and application, insures proper training of personnel in slime control methods and which insures systematic follow-through and inspection.

Microbiological Analysis

The initial analysis must be conducted at the mill under trained microbiologists, using specialized equipment and scientific methods. Because most mills do not have such facilities, the METASOL DIVISION maintains a field service of microbiologist teams equipped with portable laboratory equipment. The services of these teams are available to mills without cost. It is part of our established policy to provide paper mills with the finest in slime control products and techniques.

Programming Success

METASOL's slime control programming has been uniformly successful. In mills where it has been installed, machines are cleaner, periods between boil-outs have been lengthened, paper quality is higher and slimicide costs have been kept under control. For further information on this service, write or call us.

METASOL DIVISION, Metalsalts Corporation, 200 Wagaraw Rd., Hawthorne, N. J.

METASOL Slime Control Products are produced by Metalsalts Corporation, Hawthorne, N. J.

corporation, as a check of the effectiveness of personnel policy within separate units, and generally as an aid in planning, both for individual development and for future corporate needs.

The third problem, of keeping people, will be solved in large measure if we are successful in getting the right ones, and more importantly, in using those we get to the fullest extent of their capabilities. This is not to say these are all the conditions, but they are necessary ones. No scheme of financial rewards is an adequate substitute for job satisfaction—the feeling of each individual that in his job he is making a contribution to the common effort, and that he will be allowed and encouraged to increased that contribution to the limit of his abilities and his willingness to assume greater responsibility.

This feeling of job satisfaction will be obtained only if the whole organization is permeated with the conviction that each person should extend, and not reserve to himself, authority and responsibility. Such a philosophy must start from, and be practiced by, the head of the organization and run down through every unit.

At the same time, it will be necessary to devise and to pay for equitable compensation systems which provide adequate increases in financial reward for increased effort, performance, and responsibility, even after the impact of high personal income taxes. A rational salary structure which is sufficiently well known so that people in the company are convinced of its fairness and adequacy, is indispensable. Once set up, it must be subjected to continual review, particularly in a time of rapid wage inflation, to be sure that it properly reflects such changes, and that differentials are not gradually reduced.

In addition to an adequate salary structure, some form of incentive compensation is of great value. Many varieties have been proposed and used, and I suppose no single one is of general applicability. For maximum usefulness, it would seen that the plan should be tied directly to company earnings, should reflect individual contributions and performance rated at least annually, and should preferably be used for more than a limited number of top management people. Properly designed and administered, such plans are highly useful in creating a climate encouraging the best efforts of all individuals, and in associating their welfare with that of the corporation.

The fringe benefits—pensions, vacations, insurance plans—also are indispensable today in keeping people, partly because of tax advantages and partly because of the increasing emphasis placed on security. Such benefits, however, may be of lesser value in attracting and keeping some of the people who would be most desirable in the business—those who place lesser emphasis on security and greater emphasis on opportunity.

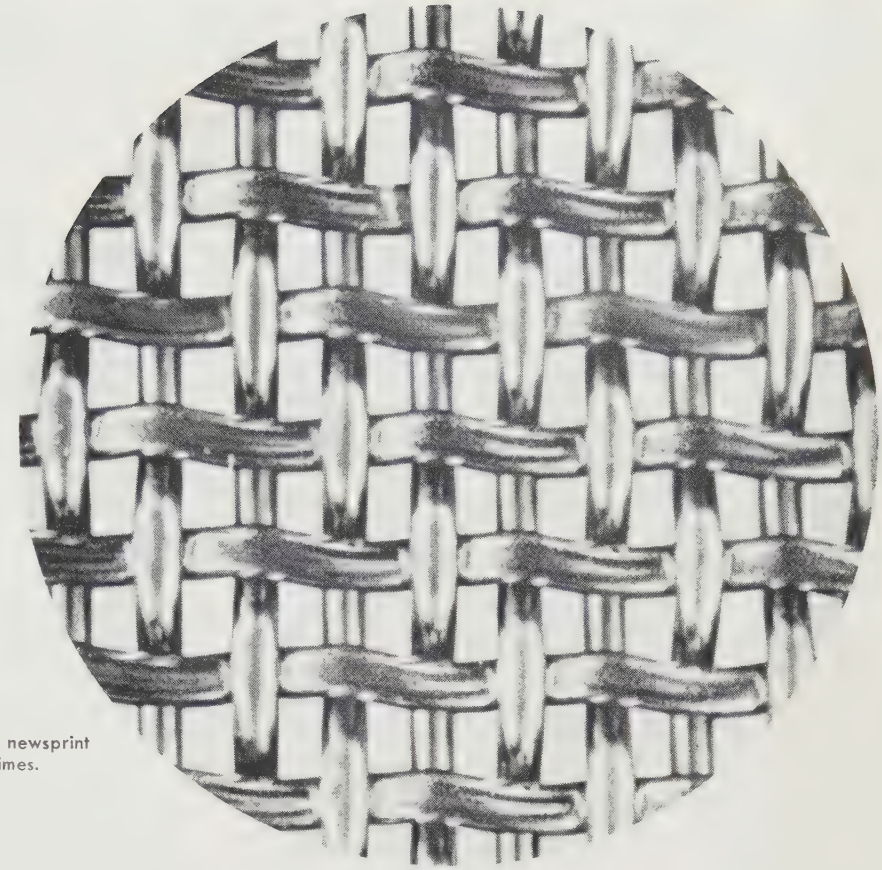
A rational salary structure, incentive compensation, and competitive fringe benefits must all be provided in our efforts to keep the more able people. None of them, however, are adequate substitutes for the proper utilization of employees, and for a climate which promotes job satisfaction and provides increasing opportunity. Therein lies the major challenge in personnel relations.

In concluding my remarks I should like to point out what seems to be the basic consideration which should govern all of our planning and policy making in this sphere. This is, that since corporations are people, direct person-to-person relationships must be maintained. Each of us has a boss, and most of us supervise the work of others. The thread which holds the corporation together is this relationship between the supervised and the supervisor. It should be kept on a direct and personal basis; it should encourage mutual understanding; and it should fully recognize the human factors involved. All of our policies, all of our administrative techniques and devices, should be designed to strengthen, and never to obscure, that relationship. Only in this way will any corporate enterprise achieve its maximum accomplishment, which is no more than the sum of the accomplishments of its people.

Presented at a meeting of the National Association of Printing Ink Makers, Asheville, N. C., May 16, 1960.

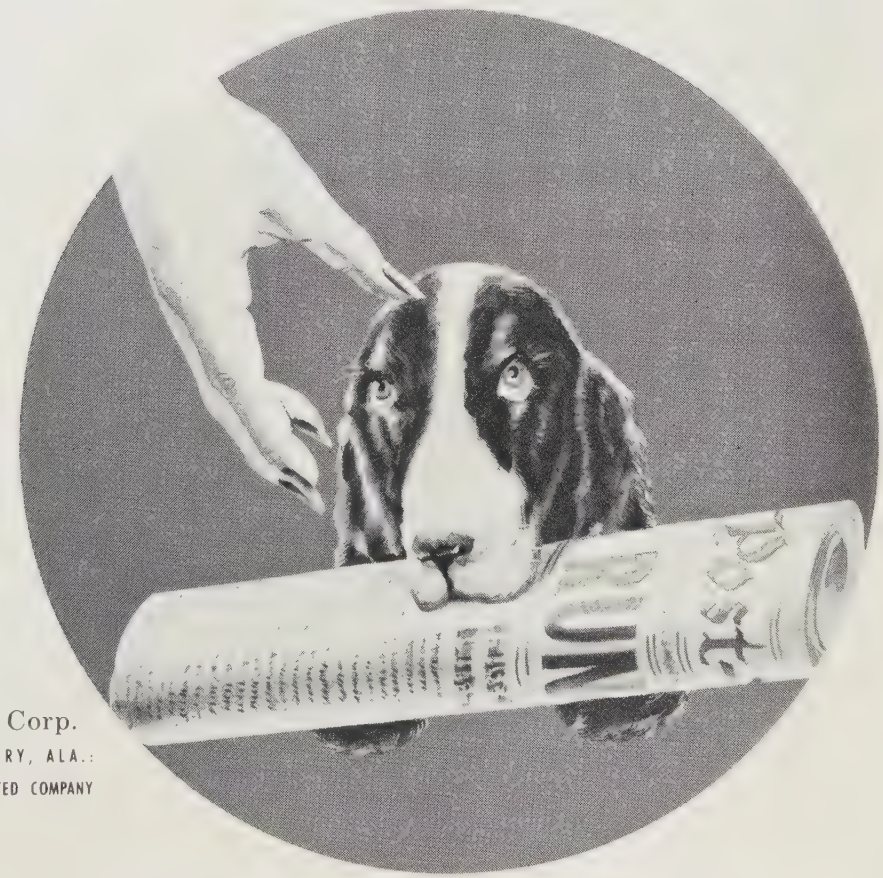
APPLETON WIRES

. . . are good wires!



Photomicrograph of newsprint wire enlarged 25 times.

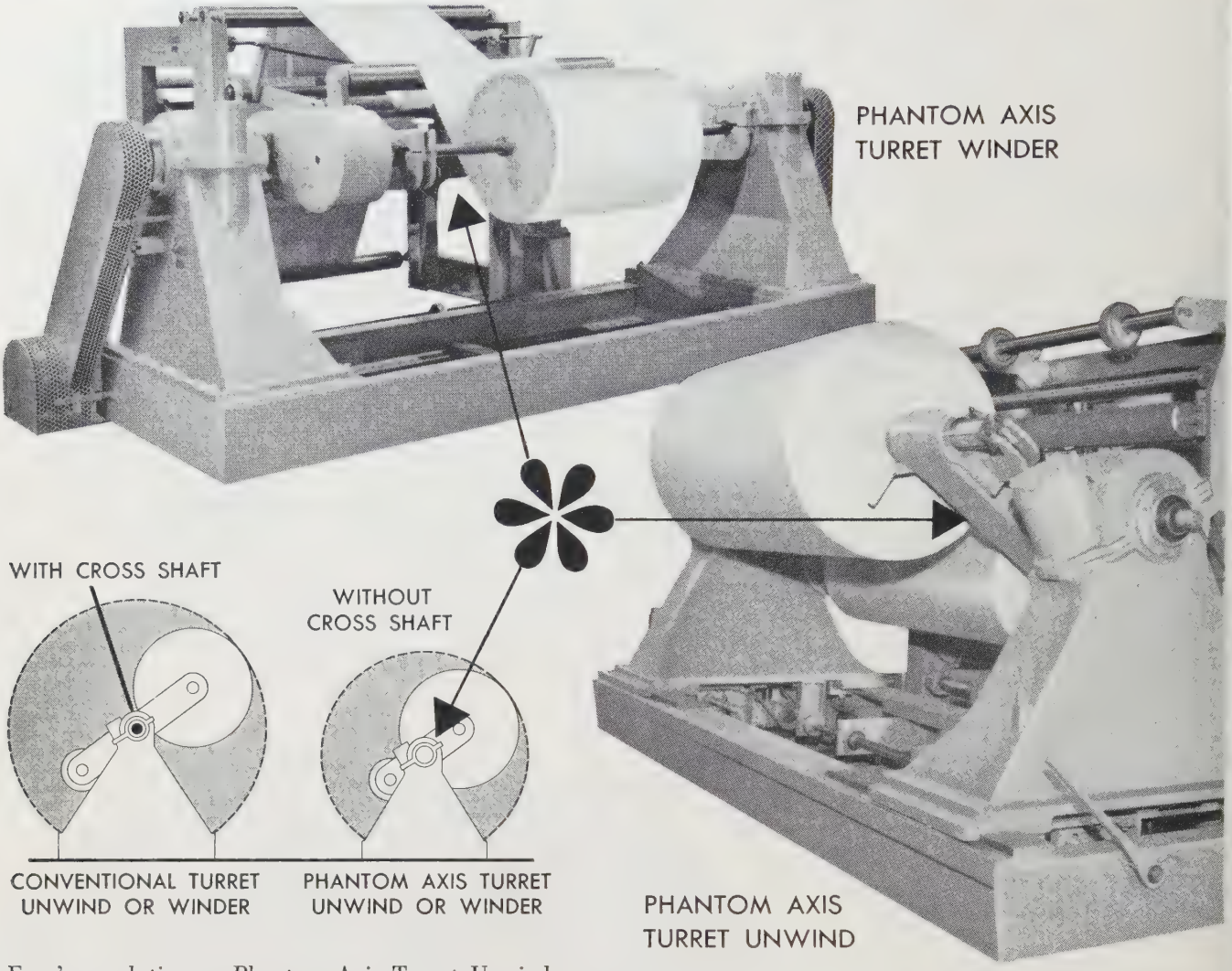
leading manufacturer of wires for NEWSPRINT



APPLETON WIRE WORKS Corp.

PLANTS AT APPLETON, WIS. AND MONTGOMERY, ALA.:
INTERNATIONAL WIRE WORKS, MENASHA, WIS. AN AFFILIATED COMPANY

IT'S WHAT'S NOT THERE THAT COUNTS*



Egan's revolutionary Phantom Axis Turret Unwinds and Winders *eliminate* the center cross shaft for greater roll diameters and more compact overall design. In addition, these units require less overhead and floor space for installation (see drawing).

The more compact design also assures greater rigidity and better operation at high speeds. Phantom Axis Unwinds and Winders are engineered to permit speeds in excess of 1000 fpm; are available in web widths through 120", and include power rotation of the turret and knife cut-off as standard features. Air chucking of cores or shafts is available at the customer's option.

ADDITIONAL FEATURES

PHANTOM AXIS UNWIND: Automatic or manual side shifting; provision for splicing with either inside or outside of web up (optional); flying splices at full machine speed; pneumatic constant tension system (optional).

PHANTOM AXIS WINDER: Side shifting available (automatic or manual); constant or tapered tension; smooth transfers at full machine speed with unique single motor design.

Egan

CABLE ADDRESS: EGANCO—SOMERVILLE (NJER)

FRANK W. EGAN & COMPANY
SOMERVILLE, NEW JERSEY

MANUFACTURERS OF PROCESSING MACHINERY FOR PAPER, FILM & FOIL, AIR DRYING SYSTEMS; ROTOGRAVURE PRINTING PRESSES; PLASTICS EXTRUDERS & ACCESSORIES; TEXTILE FINISHING MACHINERY.

LICENSEES

ACHARD-PICARD, REMY & CIE, 36 RUE D'ENGHIEN X, PARIS, FRANCE
BONE BROS. LTD., WEMBLEY, MIDDLESEX, ENGLAND
ER-WE-PA, ERKRATH, BEI DUESSELDORF, WESTERN GERMANY

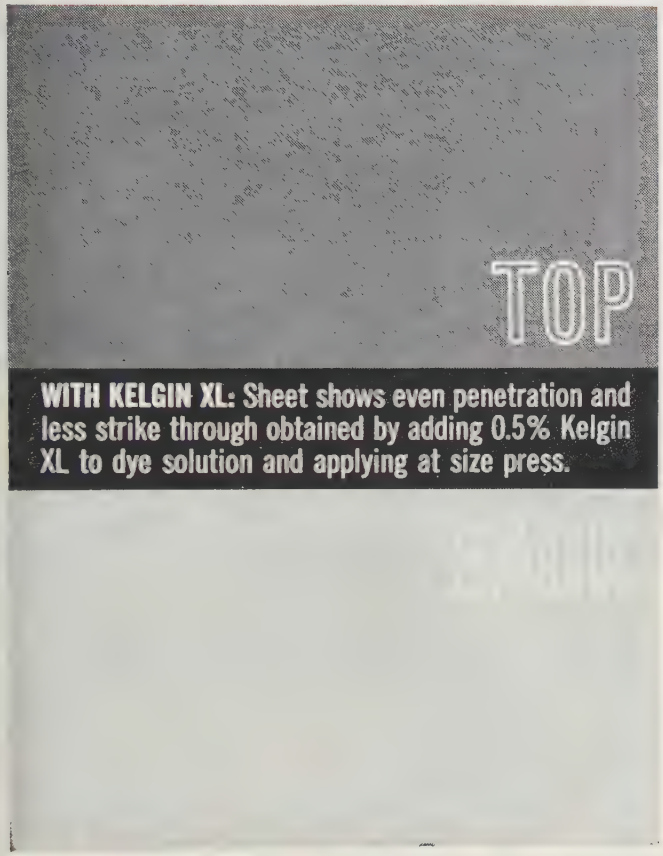
REPRESENTATIVES

ING. LEO CAMPAGNANO, VIA BORROMEI 1 B/7, MILANO, ITALY
CHUGAI BOYEKI CO., KATO BUILDING, TOKYO, JAPAN
M H. GOTTFRIED, AVENIDA 16 DE SEPTIEMBRE 10-304, MEXICO, D. F.

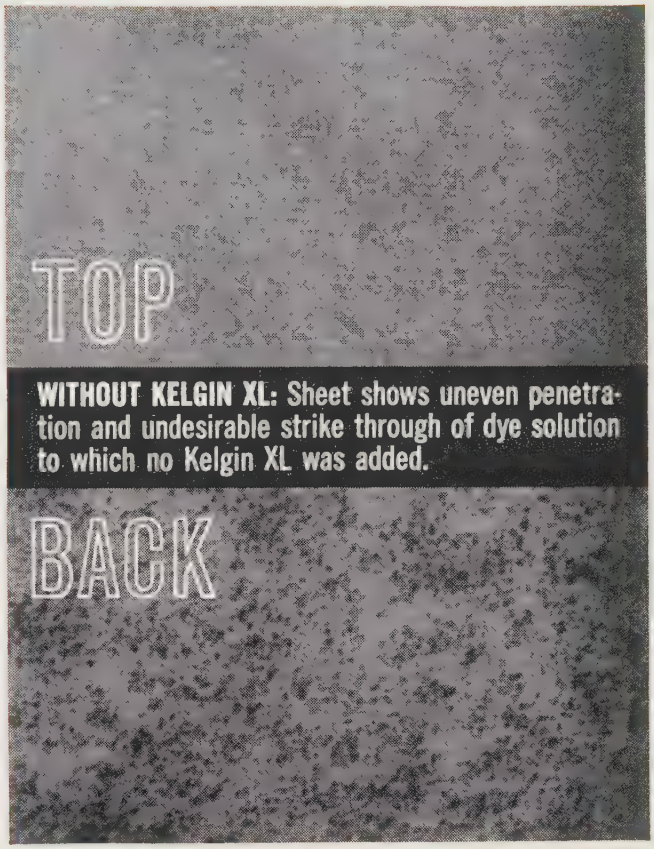
Write for complete information.

unexcelled!

THE WAY KELCO ALGIN CONTROLS PENETRATION



WITH KELGIN XL: Sheet shows even penetration and less strike through obtained by adding 0.5% Kelgin XL to dye solution and applying at size press.



WITHOUT KELGIN XL: Sheet shows uneven penetration and undesirable strike through of dye solution to which no Kelgin XL was added.

As little as 0.5% of Kelgin incorporated in dyestuff solution* provides unexcelled penetration control, minimizes undesirable strike through. These unretouched photographs show dye solution holdout properties of Kelgin XL.

*Applied at calender stack, size press, or by any other printing method.

For effective penetration control Kelco algin products that may be used are: Kelsize S, Kelgin, Kelgin LV, and Kelgin XL. Call your nearest Kelco regional office for test and technical assistance without obligation.

KELSIZE S® KELGIN® KELGIN LV KELGIN XL

products of KELCO COMPANY

75 Terminal Avenue, Clark, N. J. • 20 N. Wacker Drive, Chicago 6, Ill. • 530 W. Sixth Street, Los Angeles 14, Calif. Cable Address: KELCOALGIN — CLARKNEWJERSEY

Data on the Retention-Increasing Action of Sodium Aluminate on Titanium Dioxide and Other Fillers in the Manufacture of Paper

G. RIECK and O. HUBER

For a long time the use of finely ground minerals as paper fillers has been of great importance for the production of many first class paper qualities. The advantages resulting from the use of specific fillers are well known: They improve the brightness of the paper, increase its opacity, provide a denser and smoother surface, and improve its printability. Finally, they ensure increased stability of the sheet dimensions and yield a better paper quality after the calendering process.

An ideal filler should meet the following requirements:

1. To achieve a neutral white tone, the substance must reflect all wavelengths, within the limits of visible light, with the same intensity.
2. If possible, this reflectance should approach 100% in order to ensure a satisfactory degree of brightness.
3. The substance should show a refractive index as high as possible so that a maximum of opacity can be achieved, even in extremely thin paper.
4. It must not contain any coarse constituents and should consist of particles not exceeding a size of approx. 0.5 μ.
5. It must not be too hard in order to avoid, as far as possible, any mechanical wearing of the machines used for paper production.
6. Chemically it must be entirely inert and insoluble.
7. Finally, if possible, it should be completely retained by the emerging web of paper.

This list, to which the demand for a reasonable price should be added, for obvious reasons proves beyond doubt that it is anything but simple to find a filler which satisfies all requirements. Table I summarizes the most important properties for the more common fillers.

Table I

Substance	*Specific gravity, g./cc.*	*Refractive index, η*	*Av. particle size, μ*	*Brightness, MgO = 100%*
Natural barium sulfate	4.48	1.64	2–5	95
Blanc fixe	4.35	1.64	0.5–0.2	98
Calcium carbonate	2.7	1.56	3–5	93
Calcium carbonate, precipitated	2.7	1.56	0.2–0.5	95
China clay	2.6	1.56	1–0.5	70–90
Talcum	2.8	1.57	1–10	70–90
ZnS	4.0	2.37	0.3	98
TiO_2 anatase	3.9	2.55	0.3	98
TiO_2 rutile	4.2	2.7	0.3	98

These properties already provide valuable information with regard to the suitability of a specific substance. Fillers with a low refractive index will certainly help to provide a denser surface and increase the brightness of paper, but can only improve its opacity if their content is very high.

The opacifying action of the filler is due to the difference between the refractive indices of the fillers and the surrounding medium. Most fillers show a refractive index corresponding approximately to that of cellulose (1.53) so that an opacifying action cannot be achieved. If, in addition to this, the air enclosed in the sheet of paper ($n = 1$) is driven out of the printing area through the printing process and replaced by printing ink, the result which can frequently be observed is showthrough of the printing inks. In the same way stronger calendering will impair the opacity of the paper. (A good example of this phenomenon is the different transparency of snow and ice.)

Therefore, paper manufacturers have, to an ever increasing extent, used pigments with a high refractive index. The most popular substances are anatase and rutile which are varieties of titanium dioxide. Owing to their particularly high refractive index, their opacifying action is stronger than that of any other white pigment. Apart from their strong hiding power, their extraordinary brightness, and their neutral white tone, titanium pigments have conquered a wide field of application in the paper industry due to the uniform size of their particles, their dispersibility, their complete nontoxicity, and chemical inertness. They are used for many types of paper, including printing paper, note paper and stationery, as well as waxed, parchment, and impregnated paper. One per cent of titanium dioxide ensures the same degree of opacity as about 10 to 12% of filler with a lower refractive index, such as clay (see Figs. 1 and 2).

As a high content of filling substances reduces the strength of the paper, the desired opacity can be achieved only by a filler with a high refractive index if the other properties are not to be unreasonably impaired. The use of such substances is indispensible for increasing the brightness and opacity of thin printing paper.

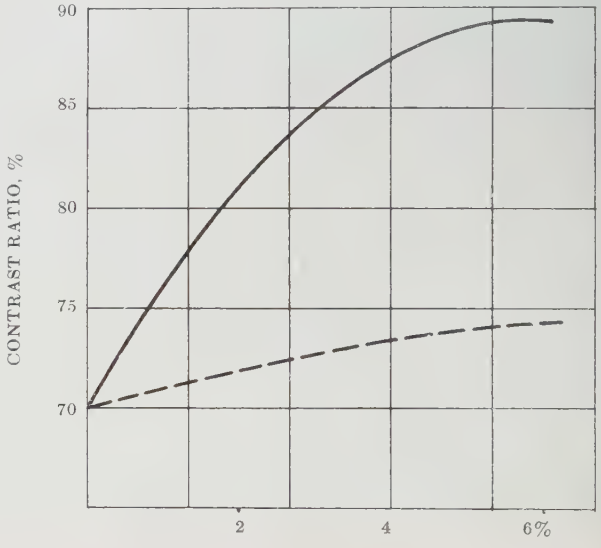


Fig. 1. Hiding power in unsized paper, 40 g./sq. m.
———KORONOS A
- - - - - Clay

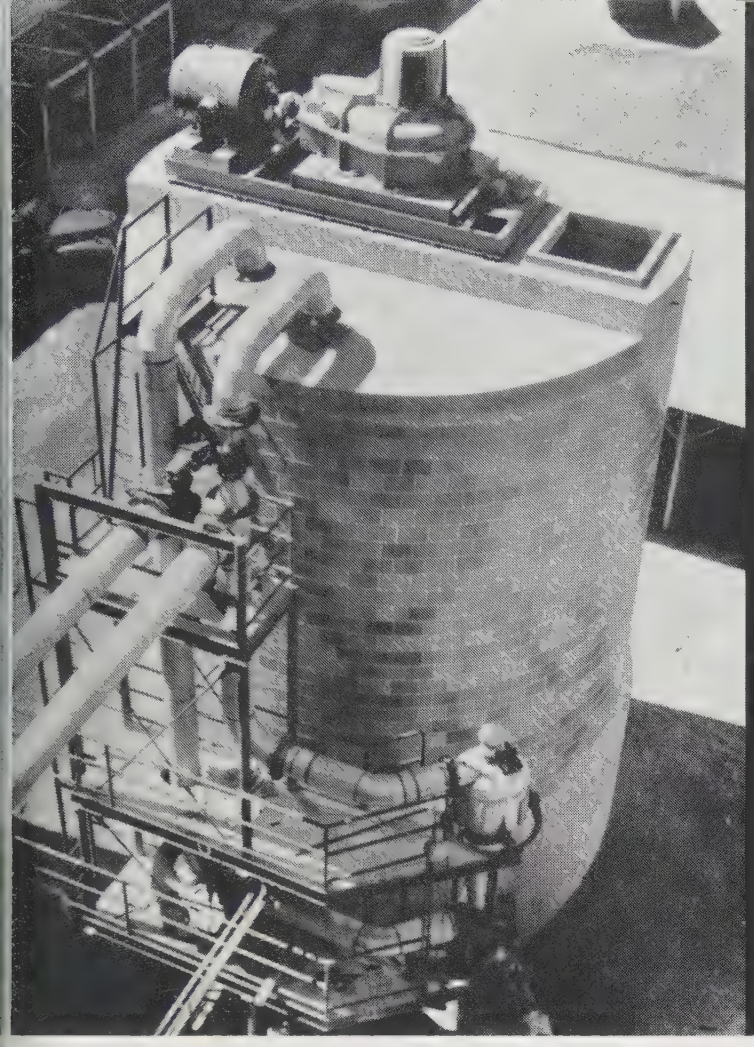
Titanium dioxide is a high-grade white pigment which is extremely suitable for papers with high opacity. It requires a complicated manufacturing process, and its price exceeds that of cheaper fillers to the same extent as its optical properties are superior to those of such substances.

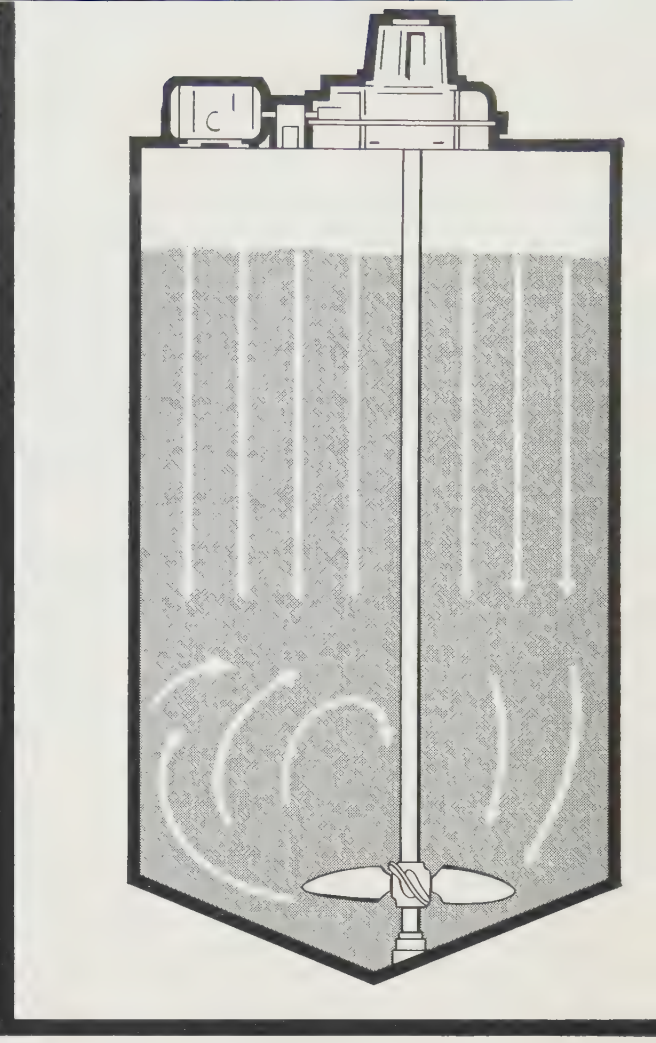
Therefore, it is not surprising that the problem of retention is given particular consideration when titanium dioxide is used. Under normal operation conditions the retention of titanium dioxide is by no means lower than that of other fillers, but any loss is more significant from the economical point of view.

Unless auxiliary agents are added, the retention of all fillers does not reach more than rather a low value (approx. 15 to 20%), because in this case it is only the result of a filtration effect. It is generally known that the presence of alum helps to increase the value of retention considerably.

The action of this substance is due, on the one hand, to flocculation of the added fillers, and, on the other, to actions

G. Rieck, Technical Service Department of Titangesellschaft m.b.H., Leverkusen, and O. Huber, the Institut der Papiertechnischen Stiftung, Munich.





How to spot a stock fluctuation before it happens

Engineers have found a fast, sure new way to get stock ready for its trip through St. Regis Paper Company's big mill at Pensacola, Fla.

Heavy stock—averaging 6%—moves out of this storage chest at a consistency that's uniform and *known in advance.*

There are no sudden up-and-down swings. Feed stock fluctuations that occur are smoothed out—end result is a fully predictable effluent. Thus it's easier for mill engineers to control the entire highly automated circuit through which the stock flows on its way to the machine.

How does it work? Sitting on top of the chest is a LIGHTNIN Mixer that develops 200 horsepower. A steel shaft reaches 28 feet down into the chest's cone bottom, where a fast-turning 8-foot diameter propeller gives the heavy stock a powerful churning.

Mixing takes place in a sharply-defined zone in the bottom third of the unbaffled chest. Within this controlled zone, stock is fully uniform. Above the agitated zone, stock is relatively motionless, but it moves in a definite plug-like flow into the agitated zone as mixed stock is drawn off. Time cycle and flow path of all stock—mixed and unmixed—are completely predictable.

How you can apply it. Wherever you want uniform stock to help your mill system run efficiently, you can get it with LIGHTNIN Mixers in your chests or tanks.

You get the precise power level you need to accomplish the job you want done within a given time. Results are guaranteed.

To get the facts on this tight-control stock mixing method, now working effectively in more than 100 mills, call in your LIGHTNIN Mixer representative (listed in Thomas' Register). Or write us today.

Lightnin® Mixers

MIXCO fluid mixing specialists

Ask for these illustrated bulletins describing LIGHTNIN Mixers:

- ☐ Laboratory and small-batch production types (B-112)
- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Data sheet for figuring general mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 142-g Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

touched off by the hydrolysis of the salt. The first phase of the reaction is:

$$Al_2(SO_4)_3 + 2H_2O = Al_2(OH)_2(SO_4)_2 + H_2SO_4$$

and when the solution is further diluted, additional SO_4^{2-} radicals are replaced by hydroxyl groups:

$$Al_2(SO_4)_3 + 4H_2O = Al_2(OH)_4SO_4 + 2H_2SO_4$$

The products of the hydrolysis tend to aggregate in the following manner: Through a condensation reaction water is released from two hydroxyl groups with two aluminum atoms being combined through an oxygen bridge: =Al—O—Al=. The condensation reaction passes through various phases and finally leads to the precipitation of a high molecular gel.

Figure 3 shows that the precipitation of alum already begins in rather acid solutions and depends on the concentration of Al^{3+} ions and the pH value of the solution. Four per cent of alum (related to dry cellulose, corresponding to an Al^{3+} ion concentration in the pulp suspension of between 0.027 and 0.0027 g.p.l.) and a pH value of approximately 4.8 will be sufficient to reach the point (see Fig. 3, point A) at which precipitation starts.

The precipitated aluminum hydroxide gel, the particles of which are very small, develops a large surface and can—due to the positive charge on its surface—effect an electrostatic combination between the negative cellulose fiber and the negative filler.

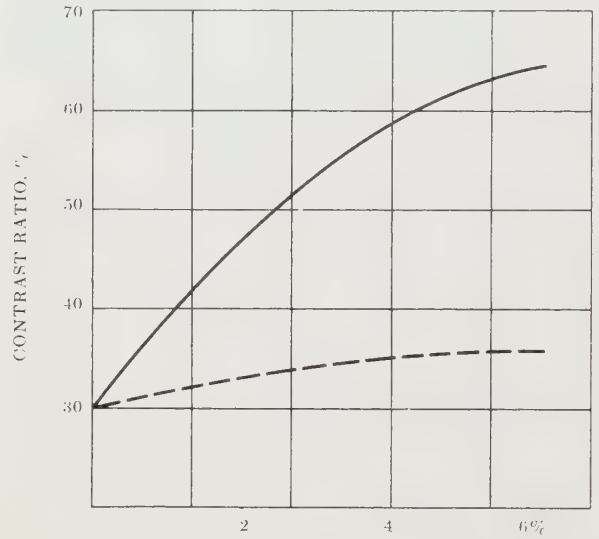


Fig. 2. Hiding power in sized paper, 40 g./sq. m.
——— KRONOS *A*
- - - - - - Clay

Thus, the retention achieved is no longer the result of a mere filtration effect and has, therefore, considerably increased. Nevertheless, the effect of alum as an agent for increasing retention is not yet sufficient for practical use.[1] (In aqueous suspensions with a pH value below 7 titanium dioxide has a positive charge. The aluminum hydroxide gel is positive as well, but the number of charges is different. It is uncertain, whether this electrostatic effect would in any way influence the retention of titanium dioxide.)

Therefore, we have carried through extensive experiments in order to find a solution ensuring that the pigment is entirely retained by the fiber. At the beginning, the experiments were based on the use of the Kämmerer experimental paper machine, while later on the results were checked on an industrial scale.

[1] As the values achieved by the individual paper mills differ considerably, it is difficult to indicate a definite figure. In general it should lie somewhere between 50 and 60%.

Besides a few other substances which we included in our experiments sodium aluminate[2] proved a very valuable agent for the increase of retention, provided that it was properly used in combination with alum. Solutions of sodium aluminate show strong hydrolytic properties and contain aluminum hydroxide in the form of a colloid. Aluminum hydroxide gel starts to precipitate as soon as the pH of the solution drops below 10 (see Fig. 4). The freshly precipitated sediment of hydroxide, which is also an amorphous substance at the beginning, develops a very large surface and thus has a high absorptive capacity.

For the purpose of obtaining the maximum surface it is advisable to produce a very fine sediment, the primary particle size of which is as small as possible. This can be achieved through rapid precipitation from concentrated solutions at low temperatures. For our experiments we, therefore, used a concentrated sodium aluminate solution consisting of: 180 g. of sodium aluminate and 820 g. of water.

The experiments showed that optimum retention results can be achieved only if the sediment develops right inside the pulp suspension. The effect is much less favourable if the sediment is developed separately by diluting the sodium aluminate solution with sulfuric acid and by adding it to the pulp after the suspension has been built up. In this case the precipitated gel is subject to a number of secondary reactions which will reduce the surface and, simultaneously, the capacity of absorption.

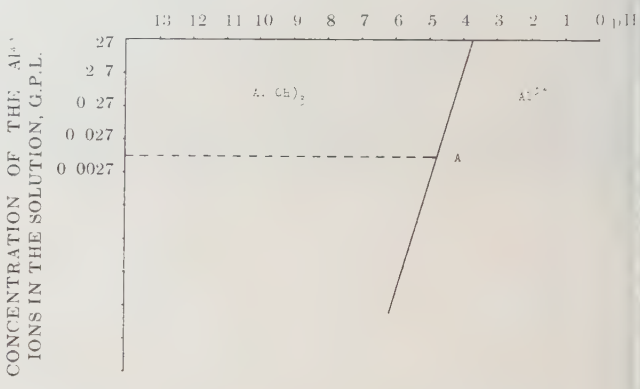


Fig. 3. Precipitation of the aluminum hydrate in relation to the pH and the concentration of the solution

For our own experiments we chose highly bleached sulfite cellulose beaten to 40° Schopper-Riegler and, as filler (related to dry cellulose), 3% of KRONOS A.

While we were using the experimental paper machine, the pulper was furnished with the following substances:

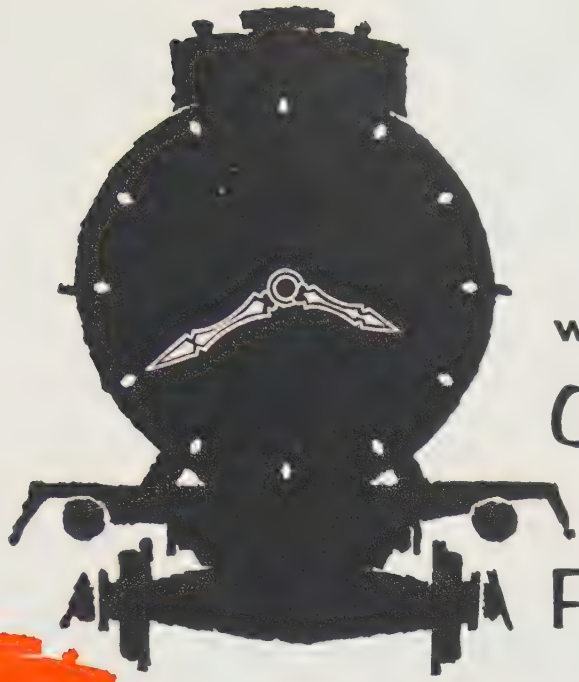
Sized paper	*Unsized paper*
Cellulose	Cellulose
3% of titanium dioxide	3% of titanium dioxide
2% of resinous glue	3 to 4% of alum
4% of alum	Aluminate solution
Aluminate solution	

Immediately before being charged to the machine the pulp inside the pulper showed a concentration of 0.5%.

In the first phases of our experiment we added different volumes of sodium aluminate solution. Results proved that an increasing quantity of aluminate solution first involves an increase, but at a later stage a decline, in the value of retention (see Fig. 5). (On the basis of different

[2] See Th. Ploetz and L. Scheuring, *Das Papier* 9, p. 311 (1955); 10, p. 183 (1956); 10, p. 546 (1956).

Th. Ploetz and H. Hohenschutz, *Das Papier* 10, p. 406 (1956). In these publications the increase of the initial tensile strength of wet paper and the favorable influence of sodium aluminate on resinous glue are reported.



when you need

CAUSTIC *FAST*

. . . call

FMC® *FIRST!*

the time we save may be your own

With one of the biggest electrolytic caustic-chlorine plants in the industrial east . . . situated for fast access to railway mainlines, waterways and highways . . . we can give you superior service on both NaOH and KOH.

Since we frequently supply many customers faster than producers who are closer as the crow flies, we may be able to save as much time from order-to-delivery for you, too.

To find out, call us first the next time you need quick service on a spot shipment.

CAUSTIC SODA

Liquid 73%

Liquid 50%, Regular and Low-Chloride Grades;

Flake, Solid and Ground.

CAUSTIC POTASH

45% and 50% Liquid;

Flake.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Chlor-Alkali Division

General Sales Offices:

161 E. 42nd STREET, NEW YORK 17

fmc FOOD MACHINERY AND CHEMICAL CORPORATION ®

FOOD MACHINERY AND CHEMICAL CORPORATION

methods, including a special process of pressure treatment, the finished paper was analyzed for titanium content so that the value of retention as related to dry cellulose could be determined. A report on this is to be published.) Systematic experiments enabled us to determine the maximum quantity of sodium aluminate quite accurately. The maximum increase of retention was achieved at 1.8% related to dry cellulose. This amount was added to the pulp suspension in the form of the above-mentioned 18% solution of sodium aluminate in water. With this method of operation the values of retention for sized and unsized papers usually amounted to 85 and 90%. In cases where the individual substances were added to the furnish according to a different sequence, e.g., pulp, aluminate solution, titanium dioxide, resinous glue, and alum or where the pigment was dispersed in advance, the results obtained were practically the same. This means that it does not make any difference whether titanium dioxide is added to the beater furnish in dry condition or whether it is first dispersed. (The sample applies to the prior dispersion of agglomerated particles through wetting agents.)

As the hydrolysis of sodium aluminate yields a caustic soda solution, the addition of this substance effects a certain increase in the pH value of the pulp suspension. This increase can be counteracted by alum or the final addition of diluted sulfuric acid.

In our experiments we used diluted sulfuric acid to keep the pH value at a level of 4.8 to 5 at the end of the feeding operation.

After a number of about 40 preliminary tests on the experimental paper machine we were able to determine the most favourable conditions and achieve reproducible values of retention between 85 and 90% so that the process could finally be applied on a large-scale basis at a modern paper mill where unsized parchment body paper was manufactured. The required sodium aluminate solution in water was prepared in advance, in a wooden tub (Sodium aluminate dissolves rapidly in water.) The beater furnish was composed of the following ingredients:

250 kg. of cellulose, 25°S.R.
6 kg. of 2.4% titanium dioxide KRONOS R
5 kg. of 2% alum
25 liters of an 18% solution of sodium aluminate (to be added 5 to 10 min. before the end of the beating cycle).

After the pulp suspension was pumped into the pulper, the pH value amounted to 5.2. Through the addition of 500 ml. of 40% sulfuric acid per beater furnish it was made sure that the pH value at the headbox was 4.8, which is the one usually observed in the manufacture of this type of product. (This pH value must not necessarily be adhered to. The paper mill concerned just wanted to avoid any increase of the pH value for reasons which are irrelevant in this context.)

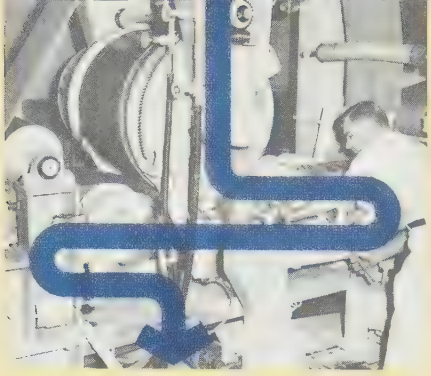
As soon as this new paper started to emerge, the radioactive isotope measuring instrument showed an increased sheet thickness so that the pulp charge had to be reduced. In view of these findings it could rightly be assumed that the retention value had increased. The determination of the amount of titanium dioxide contained in the ashed paper proved this assumption to be entirely correct.

Retention amounted to 88%, while the values previously achieved never exceeded 50%.

The paper was submitted to tests which proved that its quality had by no means deteriorated. The absorptive capacity of the paper was higher than in cases where sodium aluminate had not been used. Opacity and brightness had increased as well.

Thus, the large-scale test (operations covered several beater furnishes with 250 kg. of cellulose each) fully confirmed the results of the preliminary test. At the same time there was a noticeable improvement of waste water conditions.

felt facts
The OPEN Door
CUSTOMER SERVICE LABORATORY
Here's a specially equipped and staffed department just for you. We make physical and chemical analyses of worn felts, check for bacteria damage, offer felt washing suggestions or recommend chemical treatments if needed—all for improved felt performance.
TALK IT OVER WITH YOUR ALBANY FELT SALES ENGINEER
AF
ALBANY FELT
COMPANY
ALBANY, N. Y.
World's Largest Manufacturer of Paper Machine Felts



coating improved by Double-Wet* application

Beloit Research
dedicated to paper progress

Whether by roll application, air knife, or various trailing blade arrangements, Beloit's laboratory coating unit "proves its point" before a commercial installation is made. This type of coating research . . . in the area of advanced coating design . . . provides an essential saving in today's highly competitive coated paper and board markets. Beloit research engineers daily meet the demand for improved coating applications on grades ranging from the lightest sheet to the heaviest board grades—coating at speeds in the 3000 fpm range. Beloit "paperesearch" means *paper progress*—more efficient machines, always better paper.

AIR KNIFE FOLLOWING TRAILING-BLADE WITHOUT INTERMEDIATE DRYING

*PAT. APPLIED FOR

PHOTOS BY S. R. CHRISTENSEN

Beloit
machines
hold
speed
and
production
records
on tissue,
newsprint,
publication
grades,
kraft,
and
cylinder
board

your partner in papermaking

BELOIT
PAPER MACHINERY

Non-staining blond laminated Thilco Tuf by Thilmany Pulp & Paper Co., Kaukauna, Wisconsi

ACRI-FLO makes specialty papers better

With Acri-Flo 151, the balanced styrene acrylic latex, leading paper-makers like Thilmany are producing better specialty papers, and at lower cost. The non-staining, moisture-resistant duplex kraft shown above does an outstanding protective job under any conditions. Acri-Flo permits production of this wrap from less costly sheets . . . and, at the same time, substantially increases production efficiency. This is only one of the many ways Acri-Flo has helped the paper industry provide better products. Send a note today for technical data and literature. Find out how Acri-Flo can benefit you!

ACRI·FLO
offers:
Easier processing
Excellent UV heat-light stability
Top film-forming and pigment-binding properties

Creating Progress Through Chemistry

Chemical Division
GENERAL
THE GENERAL TIRE & RUBBER CO

THE GENERAL TIRE & RUBBER COMPANY
Chemical Division · Akron, Ohio

Chemicals for the rubber, paint, paper, textile, plastics and other industries: **GENTRO SBR** *rubber* **GENTRO-JET** *black masterbatch* • **GEN-FLO** *styrene-butadiene latices* • **GEN-TAC** *vinyl pyridine latex* • **GENTHANE** *polyurethane elastomer* • **ACRI-FLO** *styrene-acrylic latices* • **VYGEN PVC** *resins* • **KURE-BLEND** TMTD *masterbatch* • **KO-BLEND** *insoluble sulfur masterbatch*

The examination of the waste water which usually contains a noticeable share of filler and fiber residues, and the contamination of which has always been a major problem for paper manufacturers, was made the subject of another large-scale test. The type of paper which was manufactured without the application of titanium dioxide was highly filled, sized offset printing paper. For obvious reasons we do not provide any detailed information on the charge of the pulper, but confine ourselves to what is relevant for our purposes.

Furnish of the pulper:

600 kg. of cellulose
100 kg. of china clay
36 kg. of talcum resinous glue
1% resinous glue
3.5% of alum
1.8% of sodium aluminate (60 liters per furnish, as added in the form of an 18% solution).

The slight increase in pH was counteracted through the final addition of dilute sulfuric acid so that the pH value

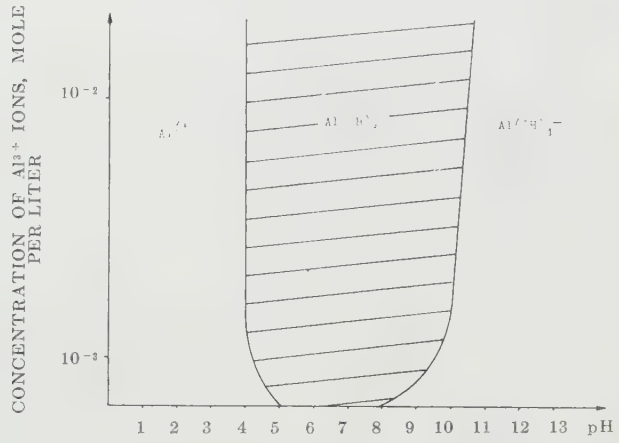


Fig. 4. Solubility of the Al-hydrate-gel in relation to he concentration of the hydrogen ions

at the headbox was restored to 4.7 to 4.8. During the test the overflow water of the conical saveall was continuously watched and sampled for analysis. (The conical saveall was not connected to any other machine.)

A considerable increase in retention could be observed immediately after the new paper started to emerge. The radioactive isotope measuring device showed an increased sheet thickness and—due to the increased retention of fine filler and fiber substances—the paper surface proved to be much smoother and denser than was the case under previous operating conditions. Another result of the increased retention was that the content of filling substances exceeded the permissible value so that the paper web was repeatedly torn apart. This difficulty could easily be removed by reducing the quantity of filler added to the furnish of the pulper.

The extent to which the added quantity of china clay and talcum was actually retained was determined by analyzing several samples of paper for their ash contents. A comparison with samples of paper manufactured according to the previous method proved what could already be expected, viz., that the value of retention had considerably increased, though it did not reach the level achieved through the application of titanium dioxide.

Even more remarkable was the clarifying effect that could be observed at the inlet of the saveall. After some 70 min. it already became obvious that the water was much cleaner than it used to be.

The waste-water analysis proved that aluminum hydroxide had an excellent coagulating effect on the fine suspended matter in the saveall. While the waste water overflow of the saveall used to contain 390 mg. of solid matter per liter of fibrous material and inorganic ingredients, the contents of solids could, in this case, be reduced to 40 mg per liter. In cases where sodium aluminate was not applied, the ash contents, i.e., the content of inorganic substances amounted to 226 mg. per liter of waste water, while our test results showed a content of no more than 25 mg. per liter.

This proves that sodium aluminate does not only help to increase the retention value, but also exercises a very favourable influence on the clarification of the waste water and contributes to an increase in final output by recovering a remarkable portion of the filler and fiber residues.

Furthermore, the analysis of waste water yielded by the normal method of production clearly proves that the use of fillers with a low refractive index results in a particularly high degree of contamination. As large quantities of filler must be used to achieve sufficient opacity and brightness, and as the retention values reached in connection with the usual methods of operation are rather low, relatively large amounts are bound to pass over into the waste water.

Tests carried out according to modified methods in plants having automatic sloping equipment led to very good results: The solution of sodium aluminate is continuously added to the pulp suspension a short time before it passes on to the machine. An automatic controller of the pH value regulates the addition of the solution of sodium aluminate. The retention values obtained by this method are sometimes even better than those which result when the sodium aluminate is added to the pulper.

Thus, if properly used, sodium aluminate will be equally

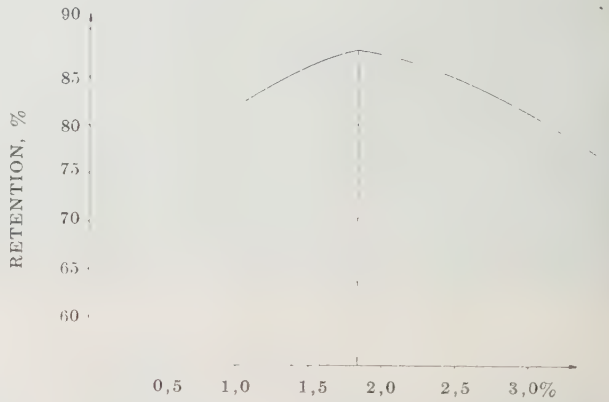


Fig. 5. Sodium aluminate related to dry cellulose

valuable for the increase of retention and the clarification of waste water. The results of our comprehensive experiments show that, on the one hand, the use of titanium dioxide ensures the production of a paper quality satisfying the requirements outlined at the beginning of this report and, on the other, provides a simple and economical solution of retention and waste water problems. The excellent clearing action of aluminum hydroxide in the saveall will almost entirely recover even the small residue of titanium dioxide. The same applies to the fiber residue, the loss of which might otherwise be considerable, if short-fiber cellulose were involved.

CONCLUSION

In various laboratory and industrial tests sodium aluminate has proved an efficient agent for improving the retention of fillers.

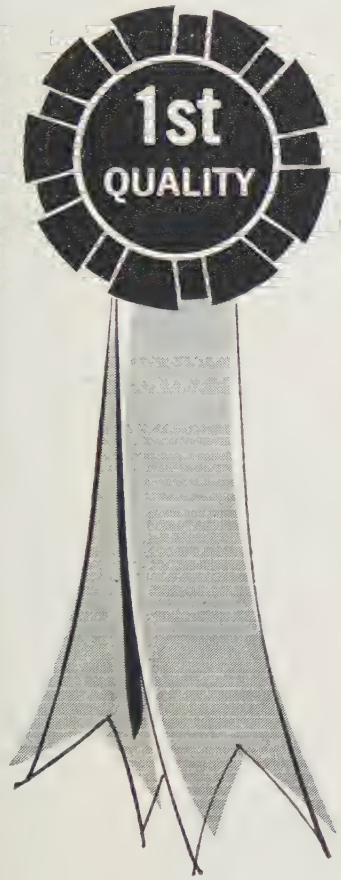
Retention and waste-water difficulties which occur with the use of titanium dioxide are easily removed by the application of sodium aluminate.

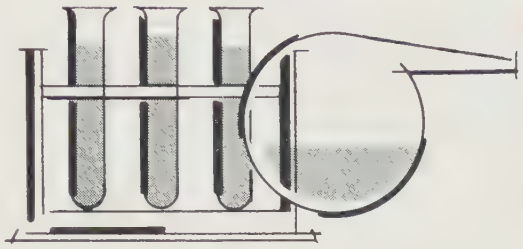
Received March 22, 1960.

YOU BENEFIT 5 WAYS

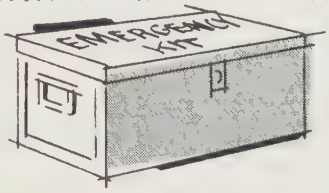
with SOLVAY CHLORINE!

PRODUCT You get chlorine made by America's foremost producer of alkalies. Outstanding in a line that has set the industry's standards!

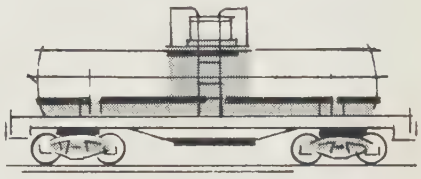




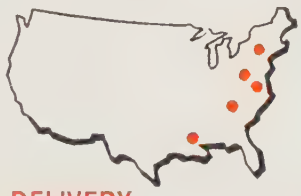
SERVICE You get the help of chlorine specialists in Solvay Technical Service working on your problems. Fast aid and expert literature in the use, handling and storage of chlorine for textiles, paper, water, sewage.



SAFETY You get safety programs and equipment pioneered by Solvay. Emergency Kits you can buy or borrow for cylinders, 1-ton containers, tank cars. Safety wall charts displaying vital unloading, handling, first aid facts.



PACKAGING You get Solvay® Liquid Chlorine in the package most convenient for you. Tank cars—32,000 lbs., 60,000 lbs., 110,000 lbs. Multiple unit cars of 15 1-ton containers. 150-lb. cylinders.



DELIVERY You get carload and l.c.l. orders speedily from production centers in Syracuse, N. Y., Moundsville, W. Va., Hopewell, Va., Brunswick, Ga., Baton Rouge, La. and a network of distribution points.

Sodium Nitrite • Calcium Chloride • Chlorine • Caustic Soda Caustic Potash • Potassium Carbonate • Sodium Bicarbonate Chloroform • Methyl Chloride • Soda Ash • Vinyl Chloride Ammonium Chloride • Methylene Chloride • Carbon Tetrachloride • Snowflake® Crystals • Monochlorobenzene • Orthodichlorobenzene • Para-dichlorobenzene • Ammonium Bicarbonate • Hydrogen Peroxide • Aluminum Chloride • Cleaning Compounds • Mutual® Chromium Chemicals

Allied Chemical

SOLVAY PROCESS DIVISION

61 Broadway, New York 6, N. Y.

SOLVAY branch offices and dealers are located in major centers from coast to coast.

SOLVAY PROCESS DIVISION
ALLIED CHEMICAL CORPORATION
61 Broadway, New York 6, N. Y.

83-70

Please send me without cost these Solvay Technical Bulletins:

- ☐ #7—"Liquid Chlorine"
- ☐ #11—"Water Analysis"
- ☐ #8—"Alkalies and Chlorine in Treatment of Municipal and Industrial Water"
- ☐ #12—"The Analysis of Liquid Chlorine and Bleach"
- ☐ #14—"Chlorine Bleach Solutions"
- ☐ Chlorine Safety Wall Chart.
- ☐ Have your representative call.

Name _____

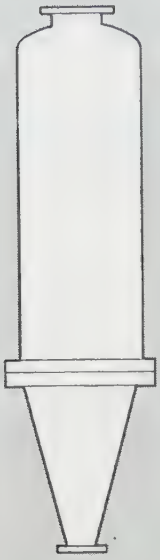
Position _____

Company _____

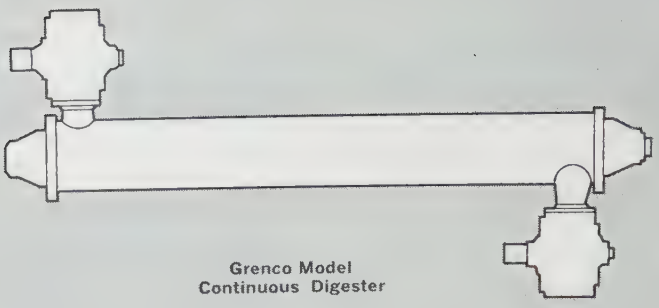
Phone _____

Address _____

City _____ Zone ____ State _____



Rapid Cycle
Batch Cooker



Grenco Model
Continuous Digester

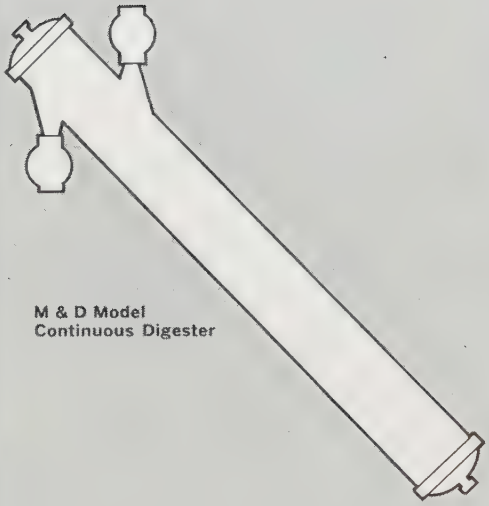
Bauer DIGESTERS

A Complete Line for All Cooking Requirements

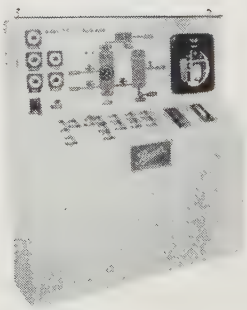
Bauer's modern line of digestion equipment is engineered specifically to help you meet modern market demands.

Featuring automatic operation, accurate control and high efficiency, this equipment includes the Rapid Cycle batch cooker and two types of continuous digesters — the Bauer M & D model and the Bauer-Grenco model. Both continuous models are equipped with the famous Bauer-Grenco rotary valve. Optional electronic controls assure maximum uniformity in any type process.

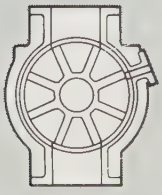
Bauer is the only supplier that can offer you, on an impartial basis, the type digestion equipment best suited to your particular needs. For more details, ask for Bulletin P-30.



M & D Model
Continuous Digester



Electronic Controls (Optional)



Grenco Rotary Valve
for Continuous Digesters

THE BAUER BROS. CO.

1715 SHERIDAN AVENUE
SPRINGFIELD, OHIO

YOUR NEW PULP/PAPER MILL AT A PREDETERMINED FIXED PRICE

A unique and economic approach to capital investments in new mills has been introduced to the industry by Kellogg through its over-all engineering-procurement-construction responsibility for Tennessee River Pulp & Paper Co's. new 500 T/D kraft pulp and liner board mill.

This method of minimizing and accurately predetermining plant costs was perfected by Kellogg through long experience in designing and building multi-million dollar projects for the oil refining and petrochemical industries—two of the world's most consistent and experienced capital investors.

Kellogg's approach, basically, is a matter of working closely with the client to integrate process and plant design, materials and equipment procurement, and all construction steps into one operation. Whether Kellogg is the sole contractor or is working with many sub-contractors, the end result is the same—a highly efficient plant at a predetermined fixed price.

Executives interested in learning more about this economic and proved approach to new production facilities are invited to write for Kellogg's brochure—"Planning the New Plant for Profits." Your copy can be obtained promptly by returning the coupon.

KELLOGG

THE M. W. KELLOGG COMPANY
(A subsidiary of Pullman Incorporated)
711 Third Avenue, New York 17, N. Y.

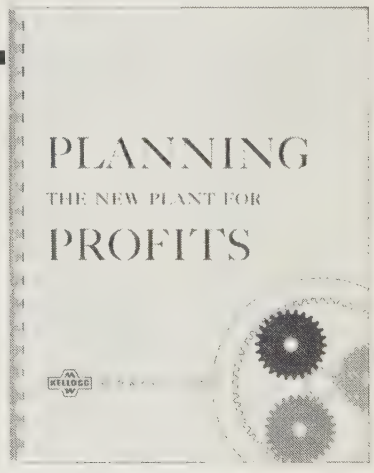
Please send copy of brochure—"Planning the New Plant for Profits."

Name_____

Title_____

Company_____

Address_____



ANNOUNCING

A unique new paper coating latex with an unequalled combination of properties

Naugatex 2752

Naugatex 2752 is a new styrene-butadiene latex specifically designed to meet the requirements of the offset coated paper and board industry. A product of advanced polymerization techniques, it offers papermakers a combination of coating properties that has never been matched in the industry.

Compared with conventional styrene-butadiene latex, Naugatex 2752 offers these advantages:

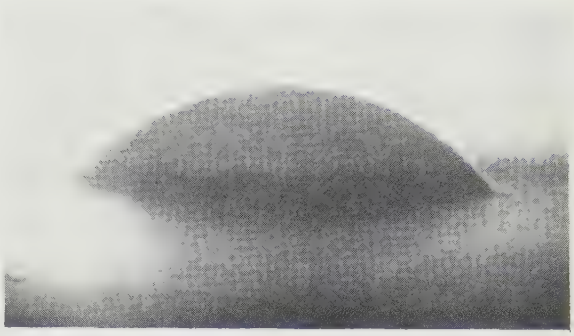
- **Very high pigment binding strength**
- **Exceptional mechanical stability**
- **Increased activity with melamine-formaldehyde/starch adhesives**

Above all, paper coated with Naugatex 2752 now offers offset printing customers a paper with *lower water sensitivity*, assuring:

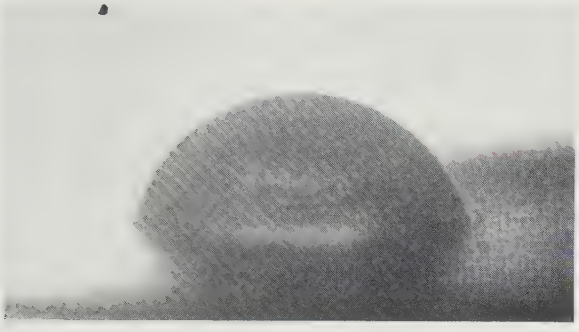
1. **Less curl**
2. **Greater wet pick resistance**
3. **Reduced press difficulties from tinting, scumming and piling**

Learn more of the advantages offered by this remarkable new latex. Write to address below for literature which details test data showing why NAUGATEX 2752 represents a major advance in paper coating technology.

3 SEC.

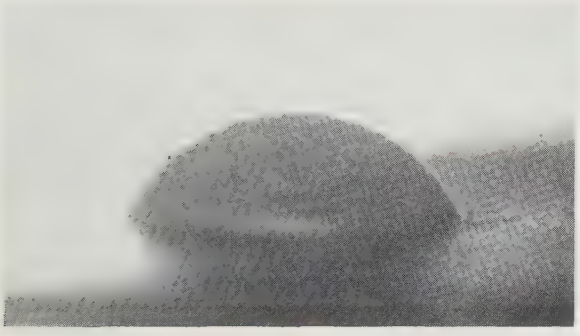


3 SEC.

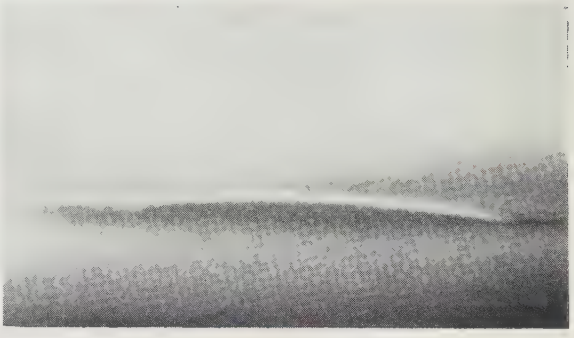


8 SEC.

8 SEC.



30 SEC.



30 SEC.

These photomicrographs of water droplets (magnified 20 times) illustrate clearly how Naugatex 2752 increases the contact angle of coated offset papers. The reduced surface wettability of the Naugatex-treated paper (left) as compared with a leading competitive latex (right) is a direct function of the low surface activity exhibited by new 2752. Because of reduced moisture sensitivity, coated offset papers formulated with Naugatex 2752 present fewer printing difficulties due to scumming (wet-pick), plate tinting and curl.

Latex from the Industry's Pioneer

NAUGATEX®—Copolymers of Butadiene-Styrene-Elastomeric
—Copolymers of Butadiene-Styrene-Resin

NITREX®—Copolymers of Acrylonitrile-Butadiene

PYRATEX®—Terpolymers of Butadiene-Vinyl Pyridine-Styrene

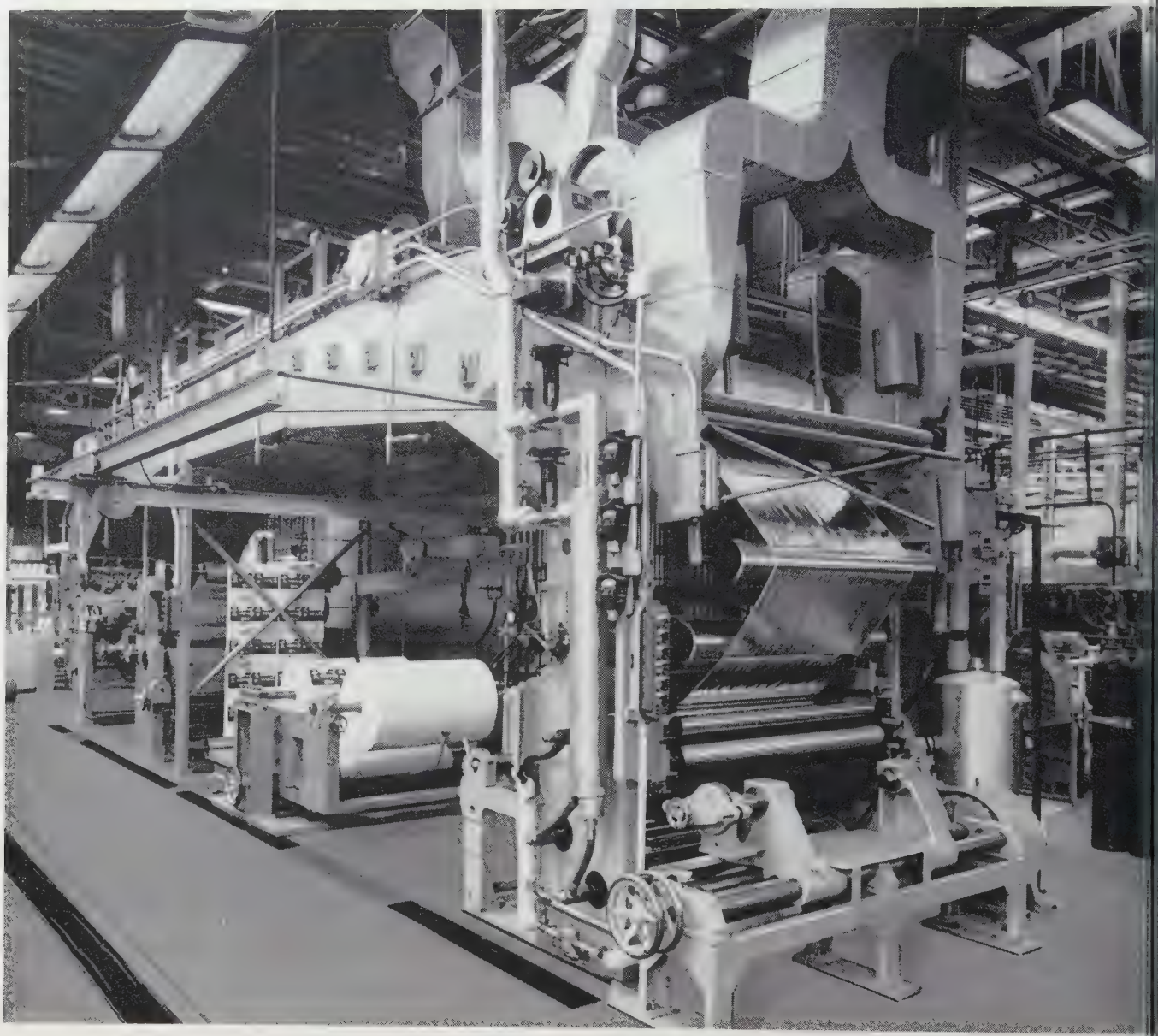
HEVEA—Natural latex

United States Rubber

Naugatuck Chemical Division Dept. 765L, Elm Street Naugatuck, Connecticut

Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices

DIST. OFFICES: Akron • Boston • Portland • San Francisco • Gastonia • Chicago • Los Angeles • Memphis • New York • Philadelphia • CANADA: Latex Division, Dominion Rubber Company, Ltd., Montreal • CABLE: Rubexport, N. Y.



Inta-Roto GM-2000 Laminator Expands Western-Waxide Facilities

Above is an actual photo of the Inta-Roto GM-2000 Laminator in use at Western-Waxide Division, Crown Zellerbach Corporation, San Leandro, California, headquarters plant. David J. Benjamin, Vice-President of the company, had this to say about the GM-2000: "This machine is the finest of its kind for the production of high precision laminated and/or coated flexible packaging materials.

"With this new laminator, Western-Waxide will be able to both adhesive and wax laminate foil to paper and/or board up to 54" in width, either polycoated or plain. We will also be able to wax or lacquer coat, dry bond transparent film to foil and hot stretch laminate films."

Since the installation at Western-Waxide, GM-2000 Laminators have been installed at Kaiser Aluminum & Chemical Corp., and R. J. Reynolds Tobacco Co. An early prototype is in use at Milprint Inc. The GM-2000 is constructed on a unit basis and can be modified to meet your requirements.

INTA-ROTO MACHINE CO., INC.

P. O. BOX 454, BYRD AIRPORT, RICHMOND 3, VA.
PHONE: REPUBLIC 7-4181

Canadian Representative: G. W. Keates,
133 Flora Drive, Scarborough, Ontario

deep ... deeper ...
deepest blacks!

COLD WATER SOLUBLE

ERIE BLACK GPNF

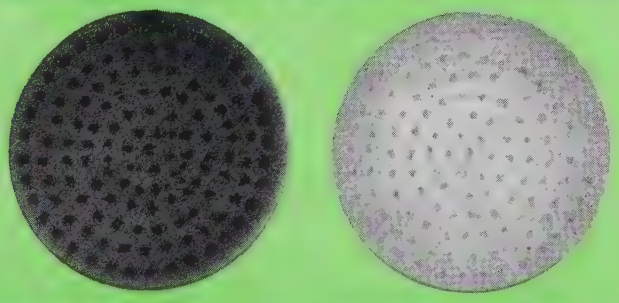
Outstanding solubility of this improved direct black is your key to cleaner, lower-cost dyeings.

Because of its extra efficiency, dye yields are materially increased. Rich, deep blacks are produced without bronzing. Specking is eliminated in lighter shades. Formulations dye on shade, time after time.

Another advantage: Erie Black GPNF is non-foaming ... doesn't cause bubbles on the screen, eliminates consequent pinholing.

This exceptional product is another in the range of "new" National® Paper Dyes designed to give you modern dyestuffs engineered for continuous dyeing, dry application and other new money-saving dyeing techniques. Our representative will gladly discuss our quality improvement program with you.

Samples of Erie Black GPNF on request



To demonstrate comparative solubilities, 75 mg. each of Erie Black GPNF and a competitive type were dissolved in 50 ml. of cold water and filtered. Clogged filter paper (left) is typical of most competitive dyes. None filters as cleanly as cold-water soluble, non-foaming Erie Black GPNF (right).

NATIONAL ANILINE DIVISION
40 RECTOR STREET, NEW YORK 6, N. Y.

Atlanta Boston Charlotte Chicago Greensboro Los Angeles
Philadelphia Portland, Ore. Providence San Francisco

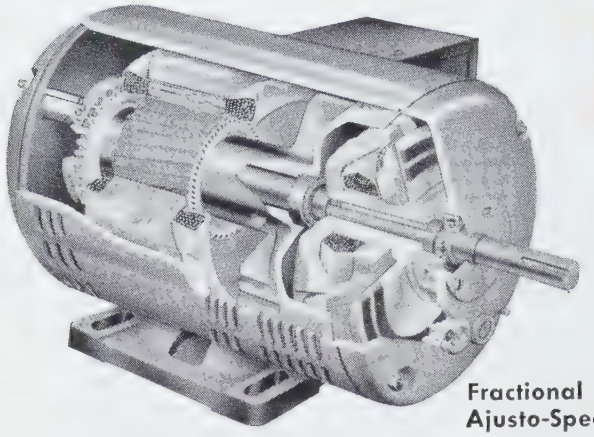
In Canada: ALLIED CHEMICAL CANADA, LTD., 100 North Queen St., Toronto 18

Distributors throughout the world. For information:
ALLIED CHEMICAL INTERNATIONAL • 40 Rector St., New York 6, N. Y.

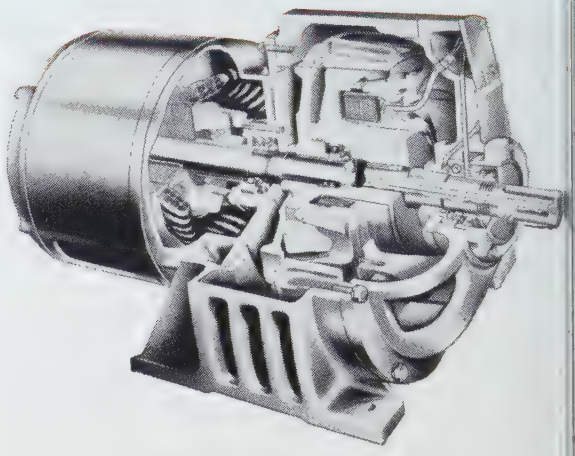
Allied Chemical

Bring Your Speed Control Problems to

EDDY-CURRENT HEADQUARTERS



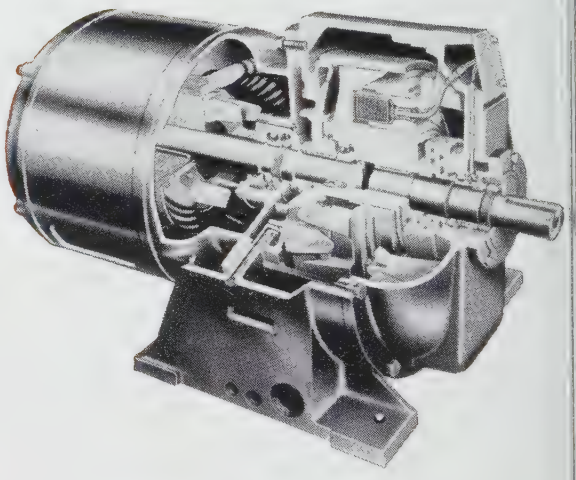
Fractional HP
Ajusto-Spede Drive



Air-Cooled Ajusto-Spede Drive

EATON
DYNAMATIC®

Let Our Years of Speed Control Experience Go to Work for You!



Dynaspede Adjustable Speed Drive

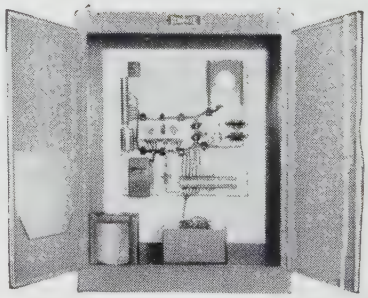
30 years ago Dynamatic pioneered the utilization of eddy-currents in industrial rotating equipment. Today, the Dynamatic Division of Eaton Manufacturing Company is the recognized leader in the development and production of eddy-current drives, couplings, brakes, and dynamometers—equipment which is solving production problems in every major industry.

In speed control applications, Eaton-Dynamatic Eddy-Current Equipment offers many exclusive advantages—stepless adjustable speeds from AC power, rapid response, wide speed range, quiet operation, low power loss, low maintenance cost, remote control, simple electronic or transistorized control.

Dynamatic Eddy-Current Equipment is available in sizes from ¼ hp Ajusto-Spede Drives to heavy-duty couplings rated up to 20,000 hp—and larger.

When you have a speed control or drive problem, bring it to "Eddy-Current Headquarters"—we can provide a simple, economical solution.

Write for Illustrated Descriptive Literature



Magnetic Amplifier (Transistorized) Control

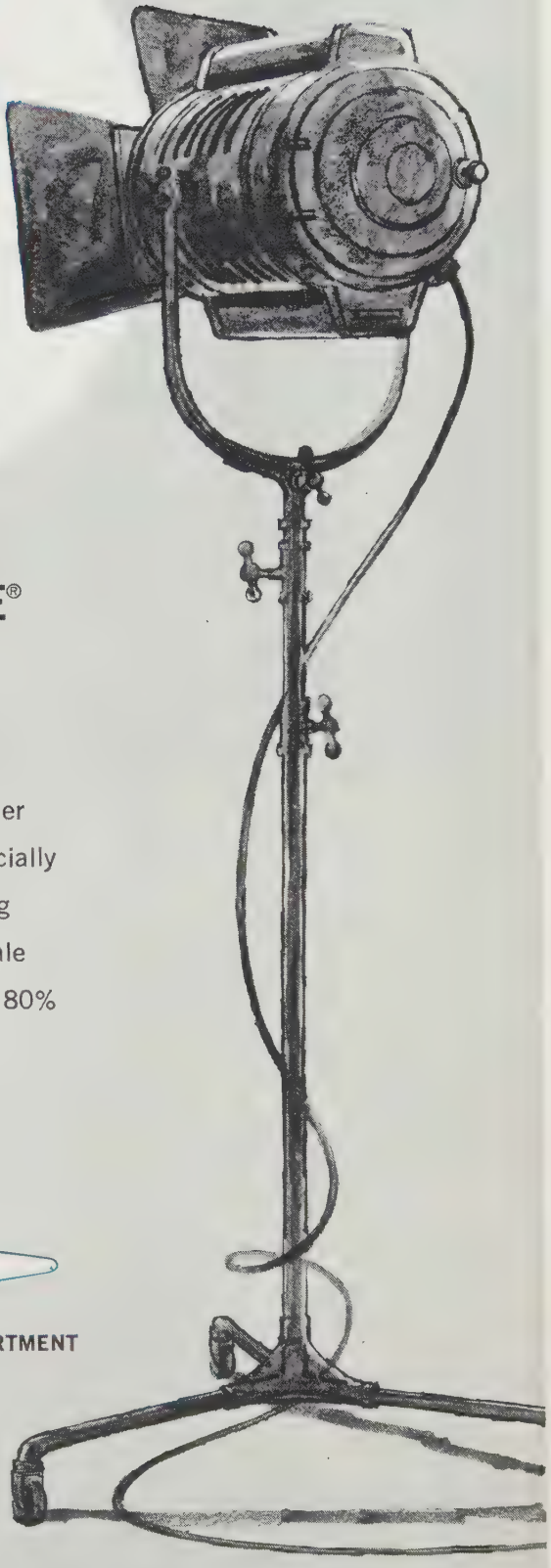
EATON®

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

ACCOBRITE

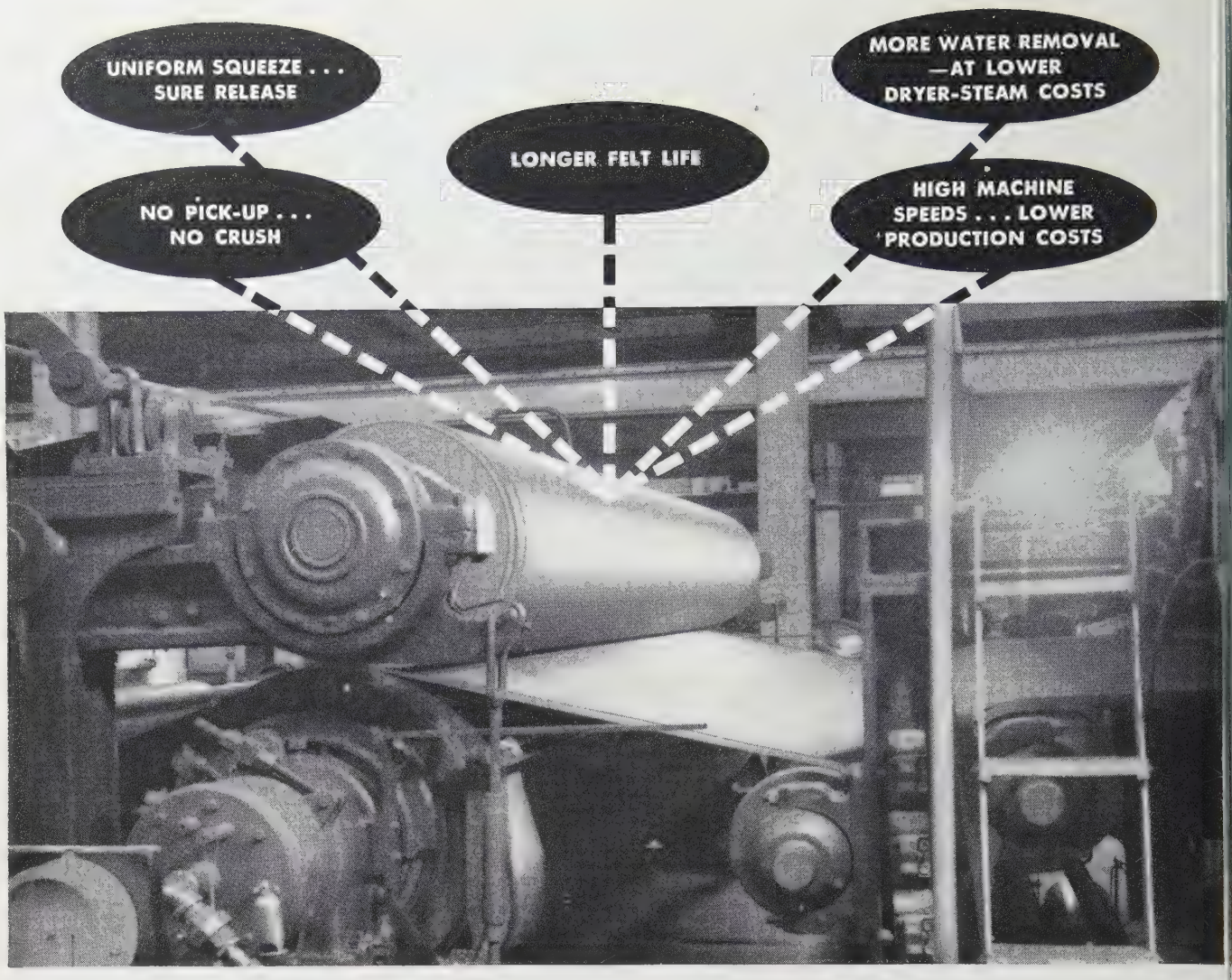
LIGHTEST COLORS IN THE ROSIN SIZE SCALE AVAILABLE IN ACCOBRITE® ROSIN SIZES



These efficient unfortified gum rosin sizes are proving they can equal the results of far costlier fortified sizes in many mills. Features include especially bright color, high sizing efficiency, low foaming qualities. The lightest colors in the rosin size scale are available in Accobrite. Shipped at 70% or 80% solids, and dry form. For further information and any technical assistance you need, call your Cyanamid paper chemicals representative.

CYANAMID

AMERICAN CYANAMID COMPANY • PAPER CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.


UNIFORM SQUEEZE . . . SURE RELEASE
NO PICK-UP . . . NO CRUSH
LONGER FELT LIFE
MORE WATER REMOVAL —AT LOWER DRYER-STEAM COSTS
HIGH MACHINE SPEEDS . . . LOWER PRODUCTION COSTS

Get all these Performance Advantages

WITH MANHATTAN RUBBER COVERED ROLLS!

Advanced roll covering facilities and skilled craftsmanship at Manhattan assure trouble-free roll performance—at lower costs—for every stage of your papermaking operations.

- **An inseparable bond of rubber-to-metal eliminates cover separation**
- **Cover compounds won't crack, corrugate or oxidize**
- **Advanced grinding and vulcanizing facilities insure uniform, exact density—accuracy of crown dimensions within .002"**
- **Rolls require minimum regrinding—even under extreme conditions of use**

Manhattan was first to dynamically balance rolls electronically at customers' machine speeds . . . to assure *even* pressure and moisture distribution in the stock, less wear on felts, bearings and journals. Let a Manhattan roll specialist show you how to get "More Use per Dollar" with Manhattan Rubber Covered Rolls.

SPECIFY MANHATTAN RUBBER COVERED ROLLS FOR EVERY CRITICAL FUNCTION

• Press Rolls—Ray-Roc, Rub-Roc, Sham-Roc, Self-Skinner • Suction Press and Coating Rolls • Sealed-End Couch Rolls • Marblex Table Rolls

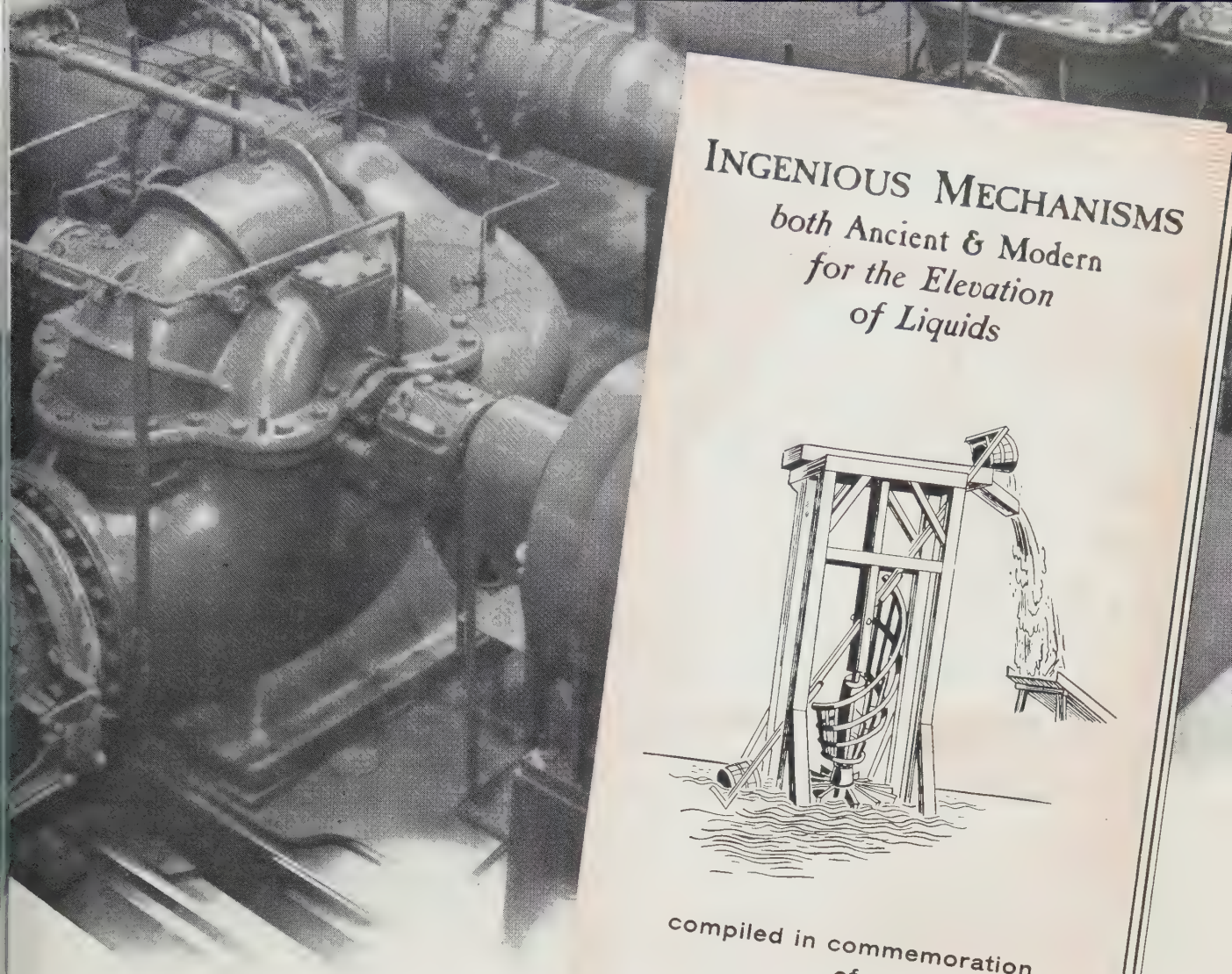
RM1050

ENGINEERED RUBBER PRODUCTS ... MORE USE PER DOLLAR

ROLL COVERING PLANTS AT PASSAIC, N. J. • NEENAH, WISC. • N. CHARLESTON, S. C.

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY



INGENIOUS MECHANISMS
both Ancient & Modern
for the Elevation
of Liquids

compiled in commemoration
of
100 YEARS
OF PUMP PROGRESS
by
Ingersoll-Rand
Hydraulics Division
1860-1960

MACHINES THAT MAKE ENGINEERING DREAMS COME TRUE

THE PUMP is one of the *oldest* mechanical devices used by man. And "engineers" from pre-history and the middle ages dreamed-up some ingenious machines for the elevation of liquids. Fourteen of these ancient and medieval devices are illustrated and described in this Anniversary Booklet which traces the development of the pump from its earliest beginnings, and also includes a summary of recent Ingersoll-Rand developments in pumping equipment. For your free copy, just send a letter or post card to Ingersoll-Rand, 11 Broadway, New York 4, N.Y., requesting Bulletin 198. There is no obligation, of course.

A CENTURY 1860 – 1960 OF PUMP PROGRESS

Ingersoll-Rand

144A10 11 BROADWAY, NEW YORK 4, N. Y.

SCOTT PAPER COMPANY produces the popular line of disposable paper products shown below, as well as other papers for industry.

Scott's famous "Wet Strength" in towels and facial tissue, and the new "Textured Softness" technique developed for paper towels, demand a high degree of quality control. Scott relies on Taylor instrumentation in its Mobile, Alabama, mill to help maintain its quality standards . . . consistently . . . dependably. Shown here are some of the instruments involved in the Chlorine Dioxide manufacturing and bleaching operations. There are many more Taylor control systems at work on other processes throughout the mill.

TAYLOR INSTRUMENTS HELP MAKE SURE THAT...

"The better the paper

Note particularly the use of TRANSCOPE* (90J) Recorders on the control panel for Chlorine Dioxide manufacture. The many outstanding features of this instrument are becoming increasingly recognized in the paper industry. Powerful servo-operated pens for high accuracy records, built-in process alarms, front-of-panel control settings, plug-in features for quick change, and 'unconfused readability' make it ideal for modern instrument control panels.

Similarly, time proven FULSCOPE* Controllers are entrusted to maintain critical variables in the 5-stage bleaching systems served by the Chlorine Dioxide system.

If you are planning an expansion or modernization program why not take advantage of Taylor's wide experience with paper mill control problems. Just call your Taylor Field Engineer, or write Taylor Instrument Companies, Rochester, New York, and Toronto, Ontario.

*Reg. U.S. Pat. Off.

Taylor Instruments

Control panel for Chlorine Dioxide process, at Scott Paper Company's Mobile, Ala., mill. Beside the washers are Fulscope Indicating and Recording Controllers on individual panels for the 5-stage bleach systems. Panels are Taylor-made.

the surer it's Scott"

SCOTT PAPER

pH measurement in the Bleach Plant. Photograph shows pH sensing system, 700T Amplifier and Pneumatic Transmitter. At bottom of the picture is Taylor 200TD Level Transmitter. Control Valve is on refrigerated water line.

Water and Stock Flow measurement in the Bleach Plant. Taylor 205 TN Volumetric sensing elements are installed in the 10" vertical line (top and center). Scott Paper is very pleased with the operation of this system.

MEAN ACCURACY FIRST

a wealth
of wet strength
with

SCRIPTITE* 40

A cationic urea-formaldehyde resin, Scriptite 40 imparts a high degree of wet strength to paper, with less resin add-on. In addition to raising tensile and wet bursting strength, Scriptite 40 also improves dry tensile strength, dry mullen, wet rub resistance, internal sizing, pick resistance, dry stiffness, dimensional stability, and folding resistance. For technical assistance, samples, and literature, write to Monsanto Chemical Company, Plastics Division, Room 779, Springfield 2, Massachusetts.

Monsanto

MONSANTO DEVELOPER IN **PLASTIC**

The Monsanto line of paper resins also includes: **SCRIPTITE 50** *for unsurpassed printability and impro surface characteristics on boxboard.* **SCRIPTITE 33** *a melamine wet-strength resin.* **SCRIPTITE 52** *in combinat with formaldehyde to give water resistance to folding boxboard and to jute liner.* **SCRIPTITE 54** *for outstand water resistance and both wet and dry rub resistance.*

HOW DO OTHER MILLS SOLVE THEIR PUMPING PROBLEMS?

1 **Glassine and grease-proof papers.** R-W Paper Company makes them for wrapping bacon, butter, hams and the like. Because of dependability in operation, R-W engineers specified Goulds pumps. Over a score of Goulds centrifugal pumps handle paper stock, hot and cold water, and waste water for various services at the plant in Longview, Washington.

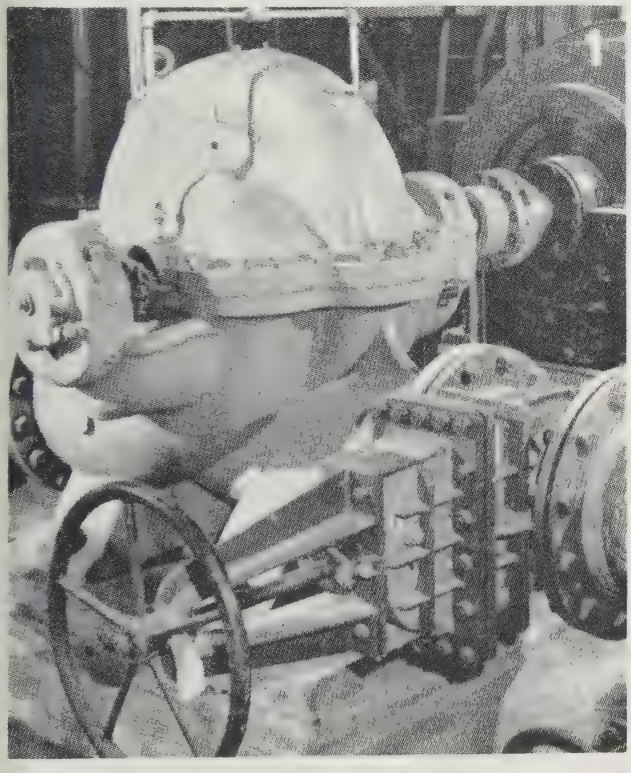
2 **Marathon Southern Corporation uses over 100 Goulds pumps.** Model 3450's for black liquor. 3405's and 3420's for white water and liquor. 3135's for stock. 3420's for fan service. 3189's for rosin size emulsion. The Goulds line is broad. It offers you a pump to solve *any* pulp and paper pumping problem.

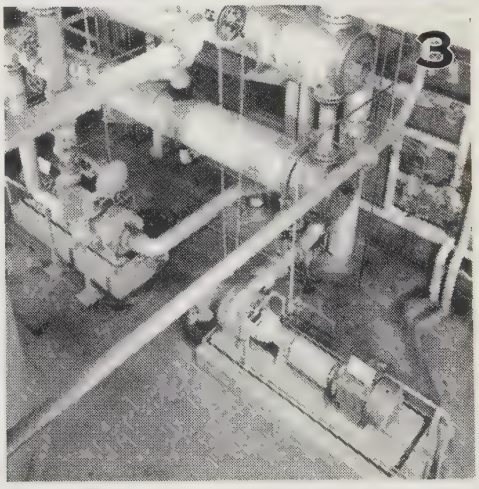
3 **Continuous digester—a real rough pumping service**—handles hot, corrosive, abrasive liquids at Hammermill Paper Co. To meet continuous digester's critical demands, Hammermill chose Goulds heavy-duty process pumps. Advantages? Extra-thick casings, water-cooled bearings, fully-open impeller are some. There are more. Write to Goulds for the full story.

4 **24-hour delivery protects $600,000 investment.** Battenville Paper Mills Inc. needed ultra-fast delivery of a pump for a new paper machine. They telephoned Goulds long distance at 11 a.m. on Thursday, had their pump at 1 p.m. Friday. Could be a moral here. When you're in a spot—call Goulds.

5 **Paper quality improved by cleaning.** The cleaner must receive the 1% white water at high pressure. For continuous operation on this tough service, Michigan Paper Company's engineers selected a Goulds 8″ Model 3405 double suction pump.

Let us help you with your pumping problems. Pumps are our *only* business. Chances are we can save you time and money. Goulds Pumps Inc., Department TA-70, Seneca Falls, New York.

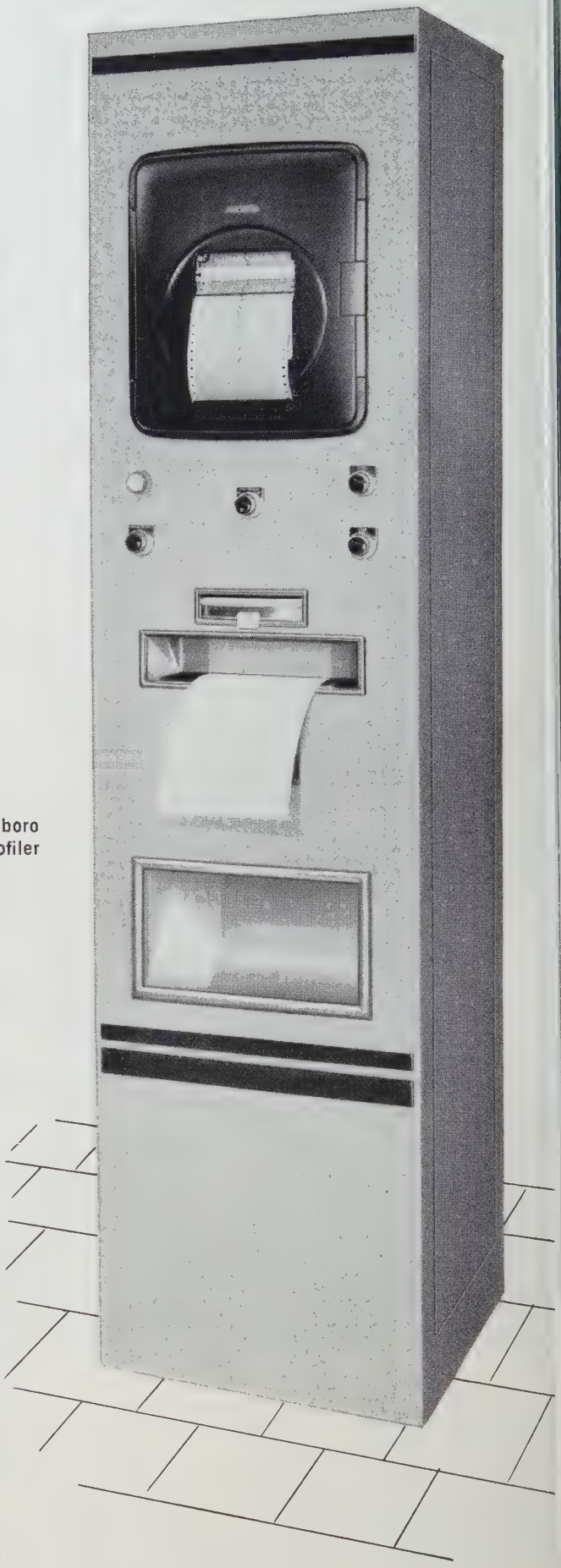




GOULDS PUMPS

NEW!

automatic profile record of paper and board thickness



the Foxboro
Caliper Profiler

Put in a sample strip, push a button, and in a matter of minutes Foxboro's new Caliper Profiler automatically gives you a continuous chart record of sheet thickness — all the way across the sheet.

The Foxboro Caliper Profiler meets all standards published in TAPPI's Code T411 m-44. It's accurate to 1/10,000 of an inch — takes samples up to 0.120 of an inch thick.

The Profiler offers a new high in quality control. Its continuous profile record shows exactly where caliper is off. No more time-consuming spot checks with hand micrometers. No awkward, cumbersome testing machines.

Get full details on how this remarkable new Foxboro instrument can help you control the quality of your paper and paperboard. Write for Bulletin 10-12A today. **The Foxboro Company, 787 Neponset Ave., Foxboro, Mass.**

FOXBORO

REG. U.S. PAT. OFF.

INSTRUMENTATION FOR THE PULP AND PAPER INDUSTRY

NO WORRIES WHEN YOU CHOOSE UNITANE®

Titanium Dioxide

The Unitane line of titanium dioxide pigments includes three anatase grades that provide outstanding opacity, whiteness and brightness, with high retention and operating flexibility. These three opacifying pigments are: Unitane 0-110, a highly water-dispersible type especially well-suited to beater and headbox additions; Unitane 0-120, a new pigment designed to give maximum retention under adverse beater conditions; Unitane 0-220, a non-water dispersible, flocculating type for high retention. Your Cyanamid Pigments representative is prepared to give more detailed information on these products and will arrange for samples.

CYANAMID

AMERICAN CYANAMID COMPANY, Pigments Division
30 Rockefeller Plaza. New York 20, N. Y.
Branch Offices and Warehouses in Principal Cities

S. R. CHRISTENSEN

Beloit Eastern's "Pat" Patterson

Here is where design for outstanding finished product processing equipment begins—under the capable direction of H. R. ("Pat") Patterson, Beloit Eastern Corporation's Chief Engineer. For ten years he has been closely associated with the design and development of Beloit equipment. Modern, functional, dependable designs are the prime concern of "Pat" and his staff of experts—drawings for translation into fine equipment by Beloit Eastern Corporation's skilled craftsmen. These men make sure that your designs are developed with close attention to detail.

FINISHED PRODUCT PROCESSING EQUIPMENT

Winders • Petite Winders • Slitters
Supercalenders • Roll Wrappers
Roll Lowering Tables • Roll and Shaft Handling Equipment • Conveyors
Unwind Stands and Tru-Tension Controls • and other equipment for the paper and allied industries.

BELOIT EASTERN PAPER MACHINERY DOWNINGTOWN, PENN.

Member Beloit Group

BELOIT EASTERN CORPORATION

DOWNINGTOWN, PENNSYLVANIA

KEEVER VICTOR STARCH

a blend of QUALITY STARCHES made to meet your EXACT requirements

How often do your paper-making problems point the finger to starch problems?

Then get acquainted with Keever — and Victor Starch. It's the only blend of wheat and corn now available to the paper industry.

Tests prove that Victor Blended Starch provides a clearer film, greater adhesive strength, more flexibility, a better fiber lay.

Victor Starch makes it possible to produce a formula best suited to nearly every starch operation in paper making.

Keever starch technicians will help you work out the ideal formula variations that make Victor Starch "custom-made" for individual requirements.

For additional information, write for Keever Data Sheet 170.

THE KEEVER STARCH COMPANY

538 East Town Street, Columbus 15, Ohio

Processors of grain products for industry since 1898

How Du Pont brighter pulp...save

Mechanical pulp bleaching...

A combination of peroxides can save up to $1.25 a ton over a hydrogen peroxide treatment.

Over 95% of all groundwood bleacheries have found that a combination of hydrogen and sodium peroxides cuts bleaching costs up to $1.25 a ton. The reason—combination formulas eliminate the use of caustic soda.

How is this possible? Because of the bleaching chemistry involved. When hydrogen peroxide is used alone, substantial quantities of caustic soda must be added to assure effective bleaching. But when sodium peroxide is part of the formula, caustic soda is formed and additional quantities aren't needed. When caustic limits of this solution are reached, hydrogen peroxide is added to complete the balance and the bleaching formula is now ready to use.

The charts below show the savings possible in a one-stage tower bleaching process when a combination of peroxides is used instead of a single hydrogen peroxide: For normal brightness, the saving runs from $.90 to $1.00 a ton; for premium brightness, $1.15 to $1.25 a ton.

You can obtain cold soda pulp and groundwood pulp brightness as high as 75 by this method. Cold soda pulp can be bleached in the refiner in absence of a bleaching tower with brightness gains up to 20 points.

For further information, get in touch with your Du Pont Representative listed at right.

EXAMPLE #1

ONE-STAGE TOWER PROCESS FOR NORMAL BRIGHTNESS

A. Using combination of peroxides

5.0% silicate
1.2% "Solozone" sodium peroxide
0.7% "Albone" 50 hydrogen peroxide

B. Using one peroxide only

5.0% silicate
1.2% NaOH
1.7% "Albone" 50 hydrogen peroxide

SAVINGS OF $.90 TO $1.00 PER TON BY USING COMBINATION OF PEROXIDES

EXAMPLE #2

ONE-STAGE TOWER PROCESS FOR PREMIUM BRIGHTNESS

A. Using combination of peroxides

5.0% silicate
1.5% "Solozone" sodium peroxide
1.25% "Albone" 50 hydrogen peroxide

B. Using one peroxide only

5.0% silicate
1.5% NaOH
2.5% "Albone" 50 hydrogen peroxide

SAVINGS OF $1.15 TO $1.25 PER TON BY USING COMBINATION OF PEROXIDES

Peroxides give you you up to $1.25 a ton!

Chemical pulp bleaching...

Peroxides—alone or in combination —give brightness up to 92 with excellent stability.

Mills throughout the country are finding that peroxides, alone or in combination, can give chemical pulp high brightness stability—without significant decrease in pulp strength or yield.

IN KRAFT BLEACHING, a five-stage process is producing outstanding results for a number of mills, among them a southern papermaker now producing over 100,000 tons of high brightness pulp annually. This process combines the best advantages of three bleaching agents—hypochlorite, chlorine dioxide and peroxide—to give brightnesses up to 90 with excellent brightness stability.

IN SULFITE BLEACHING, three peroxide processes are proving successful—a single-stage peroxide process which brightens pulp up to 75; a two-stage hypochlorite-peroxide process which brightens up to 86; a four-stage chlorine-caustic-hypochlorite-peroxide process which brightens up to 92. For information, call your Du Pont Representative listed below.

TECHNICAL SERVICE FOR YOU . . . Peroxides have a powerful bleaching action that produces high brightness pulp with excellent brightness stability. But it takes skill and experience to use peroxides efficiently. With Du Pont "Albone" hydrogen peroxide and "Solozone" sodium peroxide, you get the most authoritative advice and service available . . . from the manufacturer of *both* products.

Du Pont specialists can give you practical bleaching formulas for groundwood, cold soda, kraft and sulfite. They'll help you set up your bleaching operation, train operators, and check frequently to make sure your bleaching quality stays high and costs stay low.

Call your Du Pont representative listed below; he'll be glad to start a program to help you determine the advantages of Du Pont peroxides in your mill. Or write: Du Pont, Electrochemicals Department, Peroxygen Products Division, Wilmington 98, Delaware.

MIDWEST AREA
W. L. Liike, Chicago, Ill. • INdependence 3-7250

WEST COAST AREA
P. E. Kiefer, Portland, Oregon • CApitol 7-1281

NEW YORK & BOSTON AREA
C. R. Lombard, NewYork, N.Y. • LOngacre 3-6440

SOUTHERN AREA
R.W. Hammond, Charlotte, N.C. • FRanklin 5-5561

Or call: N. J. Stalter, Wilmington, Del. • PRospect 4-4698

DU PONT PEROXIDES

ALBONE® hydrogen peroxide

DU PONT REG. U. S. PAT. OFF.

SOLOZONE® sodium peroxide

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

GBS+ClO2
+R&D=
WONDERWHITE

Now, at last, a papermaker's dream come true...

There are a number of pulps which offer high brightness...There are others which offer high opacity.

But now Gaspesia is producing WONDERWHITE: a pulp which features *high brightness and high opacity*.

Gaspesia, with its Northern Spruce, has always been known for high opacity pulp. Now, by using Chlorine Dioxide, the highest level of brightness has been achieved—with *no loss in opacity*.

Also, you will find that WONDERWHITE has the forming properties found only in Northern sulphite pulps. Why not order a trial shipment and let WONDERWHITE tell its own story?

GASPESIA SULPHITE COMPANY LTD.
CHANDLER, QUEBEC, CANADA

SOLD BY: **Anglo Paper Products, Ltd.**
2055 Peel Street, Montreal 2, Quebec

SALES REPRESENTATIVE IN THE UNITED STATES:
Northeastern Paper Sales, Inc.
400 Madison Avenue, New York 17, N.Y.

"Reliance V★S Drive provides 60-second acceleration and precise tension control of Cameron winder

H. E. Stebner, Paper Application Engineer, Reliance Electric & Engineering Co.

"At speeds of 6,000 FPM, one of the keys to precise tension control of newsprint is electrical regenerative braking on the unwind stand. A Reliance D-c. motor powering the unwind roll acts as a drag generator, maintaining critical tension.

"For normal stopping, positive controlled deceleration is provided by regenerative braking in less than 60 seconds. Emergency stopping is a combination of dynamic and mechanical braking to provide fastest possible stopping. A VSR Regulator system controls the unwind tension, continuously compensating for WR^2 and taper tension. Another VSR Regulator holds over-all winder speed constant.

Now in use at Southland Paper Mills, Inc., Lufkin, Texas, the Cameron Winder has a capacity for a 248" mill roll, 74" in diameter, and weighing 3300 pounds. Reliance Drive equipment requires only minor maintenance, with practically no downtime caused by drive failure . . . and a uniform, high quality paper product is the result.

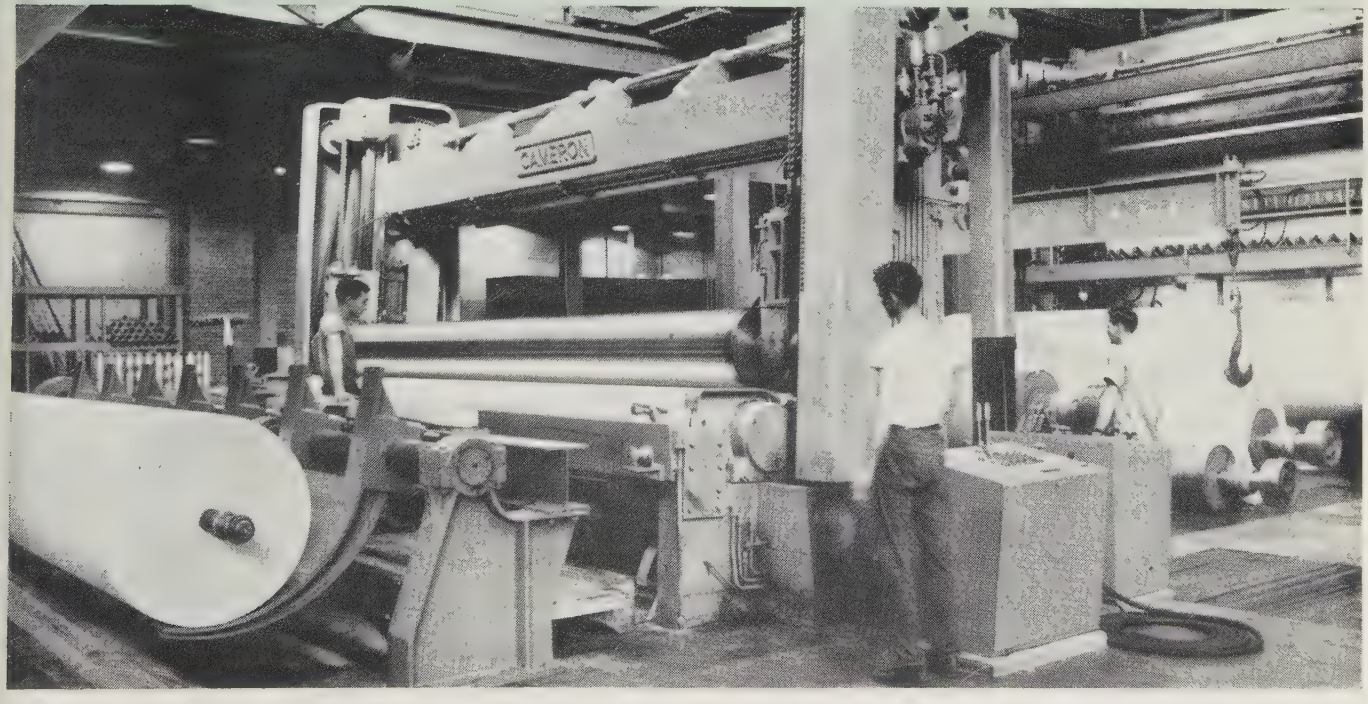
Reliance Sales Engineers are ready to apply their application skills to your drive problems. Call your nearest Reliance office or write for further information. L-1664

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 197A, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.



Tests Prove* V-10

"Safe for use in any Food Board Mill"

Rigorous tests to determine biocidal migration from the board to typical food types have proven Vineland's V-10 safe for any normal use in all food board mills. Using procedures recommended by the Federal Food and Drug Administration, representative types of paper and paperboard food packaging materials, manufactured in mills using V-10 as the biocide, were tested by a recognized Eastern laboratory to determine V-10's status under usage, within the meaning of the 1958 Food Additives Amendment.

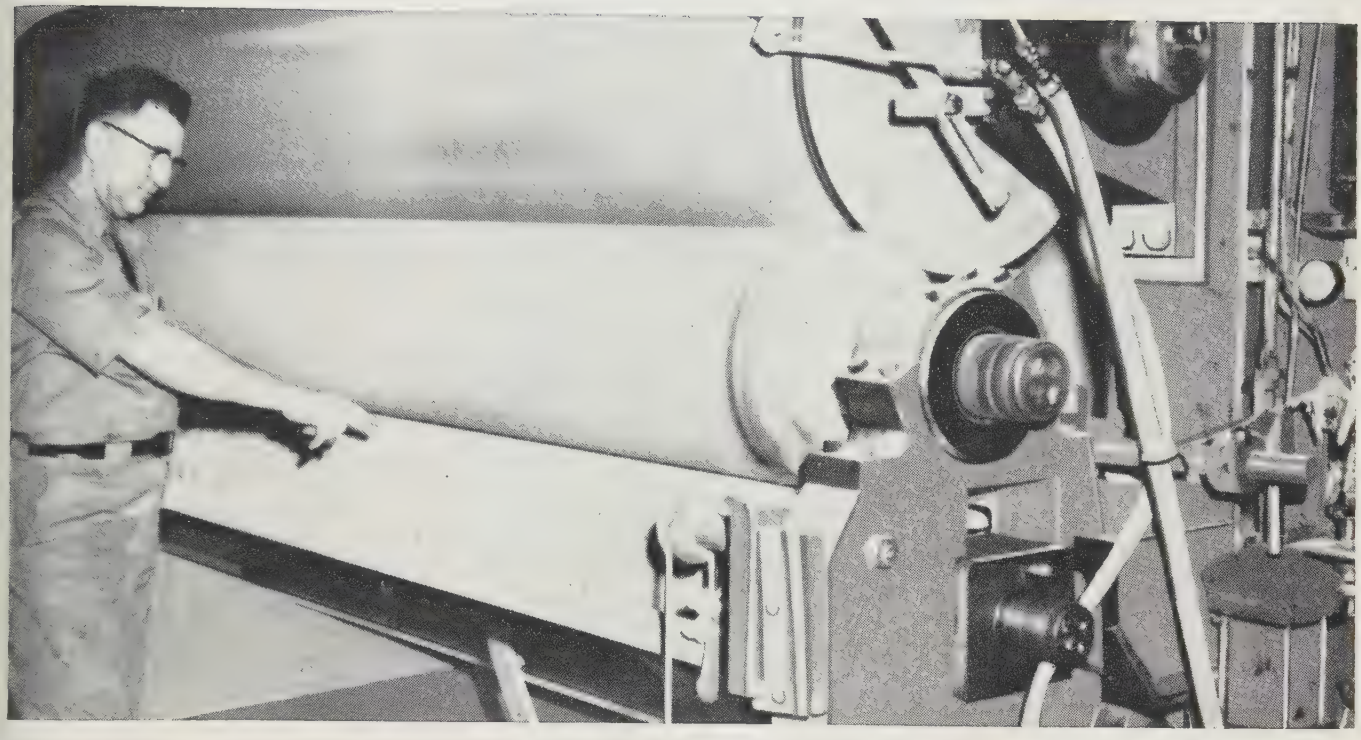
The results indicated that no migration occurred from paper or paperboard manufactured in mills using Vineland V-10! Since no migration is expected from paper packaging materials treated with V-10, its use is not subject to the Food Additives Amendment.

Use V-10 to rid your mill of all slime problems. Vineland's technical staff is always ready to assist in helping you to establish proper slime control. Bacterial population and prevalent micro-organisms will be determined at your request without cost or obligation. Write or telephone (OXford 1-3535) for free booklet "Control of Slime in the Paper Mill."

* *Test results available on request.*

Vineland Chemical Co.
West Wheat Road, Vineland, New Jersey

DYLEX® K-52 latex improves quality of enamel-coated paper at WESTVACO



West Virginia Pulp and Paper Company produces more than 1,000,000 tons of paper per year. This year, output of the Fine Papers Division mill in Luke, Maryland, will be doubled with the addition of two giant, fine papermaking machines of the most advanced design.

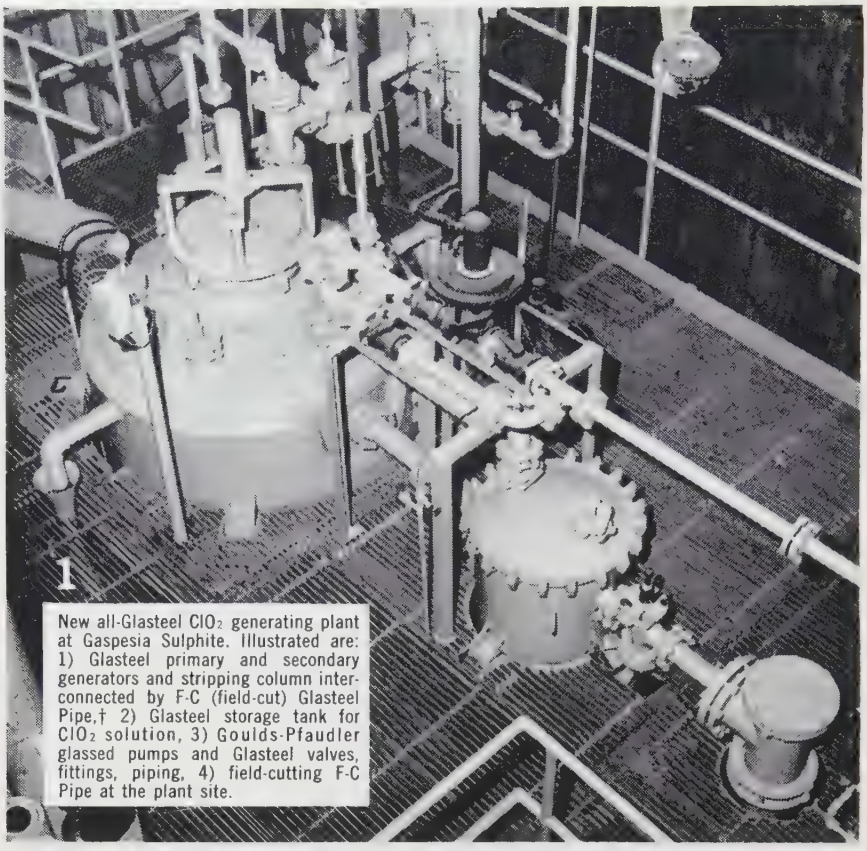
WESTVACO, a pioneer in machine coating, has found a way to improve the quality of their enamel-coated paper. They use styrene-butadiene latices as an additive in the machine-coating operation. Production supervisors at this Fine Papers Division mill report that they are pleased with the uniformity of DYLEX K-52 and its compatibility with other coating materials.

Paper coated with DYLEX K-52 is ideal for modern, high-speed printing presses because it has greater resistance to surface rupture. This coating also gives a higher gloss, excellent mechanical stability, improved pick resistance, and smoother surface which results in better printing reproduction. DYLEX K-52 is easy to apply and can be used alone or with starch or protein.

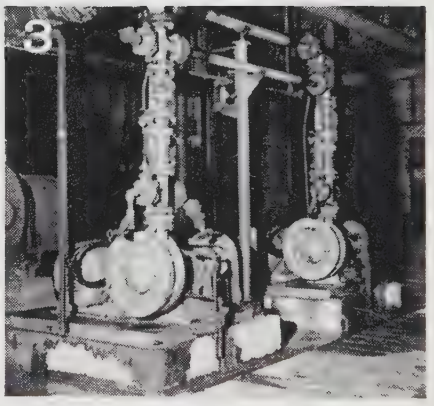
Get complete information about latex coating! Call our local sales representative, or write for our free pamphlet on DYLEX K-52 . . . complete with charts and test data. Koppers also produces DYLEX K-54 and DYLEX K-85 for the paper industry. Contact Koppers Company, Inc., Plastics Division, Pittsburgh 19, Pennsylvania.

KOPPERS PLASTICS KOPPERS

FLUIDICS* AT WORK



New all-Glasteel ClO_2 generating plant at Gaspesia Sulphite. Illustrated are: 1) Glasteel primary and secondary generators and stripping column interconnected by F-C (field-cut) Glasteel Pipe,† 2) Glasteel storage tank for ClO_2 solution, 3) Goulds-Pfaudler glassed pumps and Glasteel valves, fittings, piping, 4) field-cutting F-C Pipe at the plant site.



How to keep "puffs" down in generating ClO_2

Only two "puffs" since going on stream in November 1959. That's the record of the chlorine dioxide plant operated by Gaspesia Sulphite Company Ltd., Chandler, Quebec.

One of the important features of the "puffless wonder" is the extensive use of Pfaudler® Glasteel equipment — glass inside, steel outside.

Combat corrosion. With Glasteel you can not only keep "puffs" to a minimum, but also solve *all the corrosion problems* encountered in making and storing chlorine dioxide.

If you desire, you can get (as did Gaspesia) Pfaudler Project Engineering service to assist in the design of a complete "package" — primary and secondary generators; chlorate, chlorine dioxide, chemical, and waste liquor storage; scrubber, absorber, and stripper columns; pumps; piping; and instrumentation.

In wide use. You will find Pfaudler Glasteel equipment for ClO_2 generation used in 39 other progressive pulp mills. And always for the same reason: it is the most *economical* material available in terms of cost, maintenance and service life.

More information. For details on design, complete engineering, procurement, and installation of ClO_2 generating systems, write to our Pfaudler Division, Department TA-70, Rochester 3, New York.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

†Patent applied for

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS...the science of fluid processes

NEW PAPER LAB IN PHILADELPHIA SPEEDS DYE DATA TO MILLS

"Dye formulations in a hurry!"

That's the watchword of the new paper lab in Du Pont's District Office at 1616 Walnut Street in Philadelphia, Pennsylvania.

The lab is equipped to test paper dyes and match color samples. It was set up to provide "custom service" to mills in the Philadelphia District.

The lab is located high above Walnut Street in downtown Philadelphia. Here, stocks of practically all pulps are maintained, so as to duplicate or come close to the pulps actually used by paper mill customers. The expanded facilities also include new beating, stirring and mixing, paper-sheet-making, and drying equipment. The laboratory has a Fade-Ometer to check lightfastness, and a standard light for judging shades under all conditions.

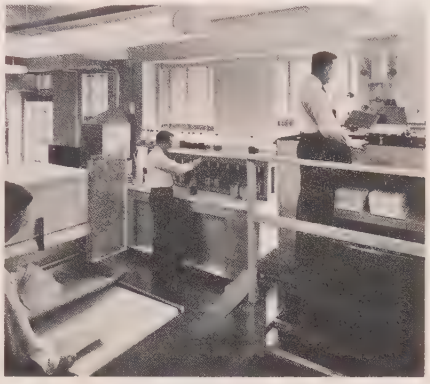
When a request for shade-matching is received, one of the lab's paper specialists checks over all the information submitted with the sample. This includes the end use of the paper, whether it is beater-dyed or surface-colored, required fastness properties and any other special requirements.

He also carefully checks the inventory record of the mill submitting the sample. His object is to prepare a paper sample using the most economical formula and whenever possible to stay within the range of dyes and stocks that the mill already has on hand. This helps avoid any delays that might arise from having to place an order for dyes or stock before production of the desired paper can begin.

After the paper sample is produced it goes back to the customer with the formula and any other recommendations.

Du Pont's Dyes & Chemicals Laboratory in Philadelphia is typical of the company's district labs throughout the country and is designed to provide top customer service in both the paper and textile fields.

If you have any paper or dyeing problems and want help, write your nearest Du Pont sales office or see your district salesman.



Making the dyed paper sample in the expanded lab facilities at Du Pont's Dyes & Chemicals District Laboratory in Philadelphia. Center, preparing the pulp slurry; right, removing the formed hand sheet; left, drying.

An over-all view of Du Pont's Dyes & Chemicals District Laboratory in Philadelphia. The lab is equipped to service both the paper and textile fields. The expanded lab facilities for paper-making can be seen in picture at right.

news from Du Pont

NEED RED OR PINK, SCARLET OR RUBY?

We printed this on this stock just to remind you that Du Pont has a balanced line of red dyes that meets all of today's paper needs.

And, in order to help you select the dye that's best for your purpose, we're printing the following listing that includes those qualities most commonly called for in a red dye. For information, write your nearest sales office, or see your Du Pont dye salesman.

Check these items:	The red to choose:
Most economical red for beater dyeing	Du Pont Purpurine 4B—Direct
For production of the bright red shades. Also tinting	Du Pont Rhodamine BM Du Pont Rhodamine B Soln. Du Pont Rhodamine 5GDN Extra
Production of scarlets and pinks. Particularly useful in tissue grades	"Pontamine"* Fast Scarlet 4BSP—4BA—Direct
For economical reds with little two-sidedness	"Pontamine" Fast Red 8BLX—Direct
Bottom side colors	Du Pont Brilliant Crocein FL—Acid "Pontacyl"* Ruby PL
For bright shades produced by dipping	"Pontacyl" Scarlet RR—Acid Du Pont Crocein Scarlet N—Acid
For the tinting of papers requiring good lightfastness	"Halopont"* Brilliant Pink 2B—Pigment "Halopont" Pink 2BM—Pigment
Bright red pigment—excellent water bleed fastness—very good lightfastness	"Lithosol"* Red CSP Paste—Pigment
Maximum fastness	"Monastral"* Red B Paste

* Reg. U. S. Pat. Off.

DU PONT OFFERS OVER 70 SURFACE ACTIVE AGENTS

There's a Du Pont Surface Active Agent that can help you in problems entailing wetting, detergency, dispersing, emulsifying, foaming, penetrating, softening, leveling, lubricating, etc.

Du Pont has a background of over thirty years' experience in surface active agents and their applications. Presently we market over seventy different products representing all ionic types: anionic, nonionic, cationic and amphoteric.

Among the *anionic* agents we offer: fatty alcohol sulfates varying in chain length from C_8 to C_{16} offered as sodium salts and some amine or alkylol amine salts; fatty alcohol phosphates which offer interesting antistatic and lubricating properties; hydrocarbon sulfonates which comprise wetting and penetrating agents, conventional detergents, as well as plasticizing and softening agents that are finding increased application in the paper field; and alkyl aromatic sulfonates which are used extensively in wet processing and cleaning operations.

Several *cationic* agents provide dye leveling, anti-graniting and lubricating properties in addition to wetting and softening properties.

Our *nonionic* agents have outstanding detergent properties. And since they are compatible with both anionic and cationic materials they often provide valuable stabilizers for the prevention of coagulation and flocculation.

Our *amphoteric* products are uniquely versatile in acting anionic in alkaline solution and cationic in acid solution. They have exhibited excellent retarding, leveling and penetrating action in a number of dye applications and are widely compatible with other chemicals.

news from Du Pont

* Reg. U. S. Pat. Off.

WHAT'S YOUR PAPER PROBLEM?

Du Pont offers broad and diversified lines of chemicals for all types of papers

Is your problem listed here? Check these items:	These, or related, chemicals and Du Pont experience could help you:
Bleaching	"Zepar"* BP reducing agent
Bleed Fastness Improvement	
Acid Dyes	"Insonite"* dye fixing agent
Basic Dyes	Du Pont Mordant BS
De-inking Assistance	"Alkanol" HCS surface active agent
Dye Fixing	Du Pont Mordant BS "Insonite" dye fixing agent
Dye Leveling	Du Pont Retarder LAN
Felt Washing	"Alkanol" HCS surface active agent "Duponol" RA surface active agent
Graniting Prevention	Du Pont Retarder LAN
Linting Reduction on Printing Grades	"Zoron" WS
Pulping Assistance	"Alkanol" HCS surface active agent
Safety Paper Chlorine Indication	"Chlorostain"* N chlorine indicator
Starch Insolubilization	"Zoron" WS resin finish
Wet Strength Imparting-surface Application	"Zoron" WS resin finish

There's probably a Du Pont chemical that can help you. We offer a broad range of detergents, emulsifiers, resins, lubricants and specialty products such as water repellents, electrically-conductive chemicals, wetting agents, and many others. For complete data, write the district office nearest you.

DU PONT
REG. U. S. PAT. OFF.

DYES AND CHEMICALS

Better Things for Better Living
. . . through Chemistry

E. I. du Pont de Nemours & Co. (Inc.)
Organic Chemicals Department
Dyes and Chemicals Division
Wilmington 98, Delaware

SALES OFFICES:

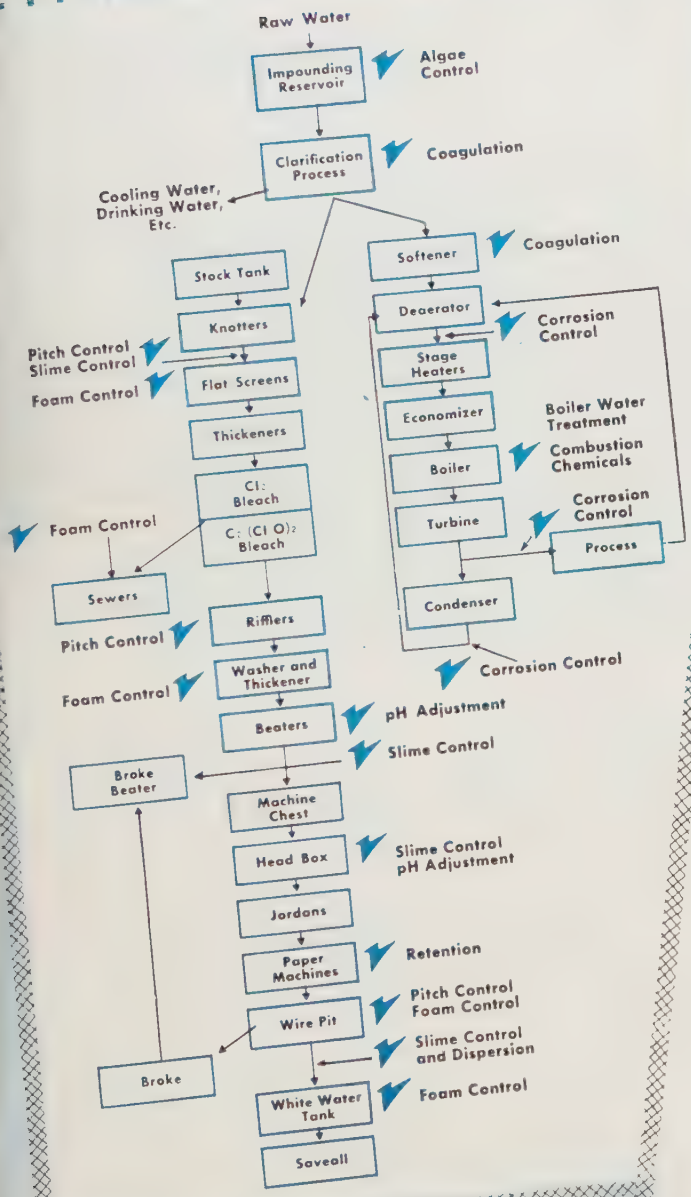
ATLANTA 3, GA. . . . 1261 Spring St. N.W.
CHARLOTTE 2, N. C. . . 427 West Fourth St.
CHICAGO 3, ILL. . . . 7 South Dearborn St.
PALO ALTO, CALIF. . . . . 701 Welch Road
NEW YORK 13, N. Y. . . . . 40 Worth St.
PHILADELPHIA 3, PA. . . . 1616 Walnut St.
PORTLAND, ORE. . . . 1238 N.W. Glisan St.
RUMFORD 16, R. I. . . . 50 North Broadway
DU PONT OF CANADA LIMITED, Montreal, Canada

HERE IS THE

COMPLETE *Nalco* PROGRAM

for Better Products at Lower Cost

. . . IN A TYPICAL MILL



NALCO has the *widest variety* of formulas to assure results in your mill, too. Here are some examples . . . representative Nalco products listed under headings which indicate the job they do. And the chart at left tells you where they are used. Your Nalco Representative will tell you more about them—or write direct to Nalco.

ALGAE CONTROL
Nalco Cuprose · Nalco 21-S · Nalco 201 · Nalco 234 · Nalco 236 · Nalco 237

COAGULATION
Nalco 600 · Nalco 650 · Nalco 680

COMBUSTION CHEMICALS
Nalco 155 · Nalco 156 · Nalco 156-C

FOAM CONTROL
Nalco 71 · Nalco 71-B · Nalco 71-C · Nalco 71-D5 · Nalco 71-K · Nalco 72

CORROSION CONTROL
Nalco 19 · Nalco 35 · Nalco 353 · Nalco 918

pH ADJUSTMENT
Nalco 680

PITCH CONTROL
Nalco 818

RETENTION AND CLARIFICATION
Nalco 600 · Nalco 650 · Nalco 680

SLIME CONTROL AND DISPERSION
Nalco 21-S · Nalco 21-M · Nalco 201 · Nalco 234 · Nalco 236 · Nalco 237

BOILER WATER TREATMENT
Nalco 75 · Nalco 718 · Nalco 728 · Nalco 752

National Aluminate Corporation is now

NALCO CHEMICAL COMPANY

6197 West 66th Place • Chicago 38, Illinois

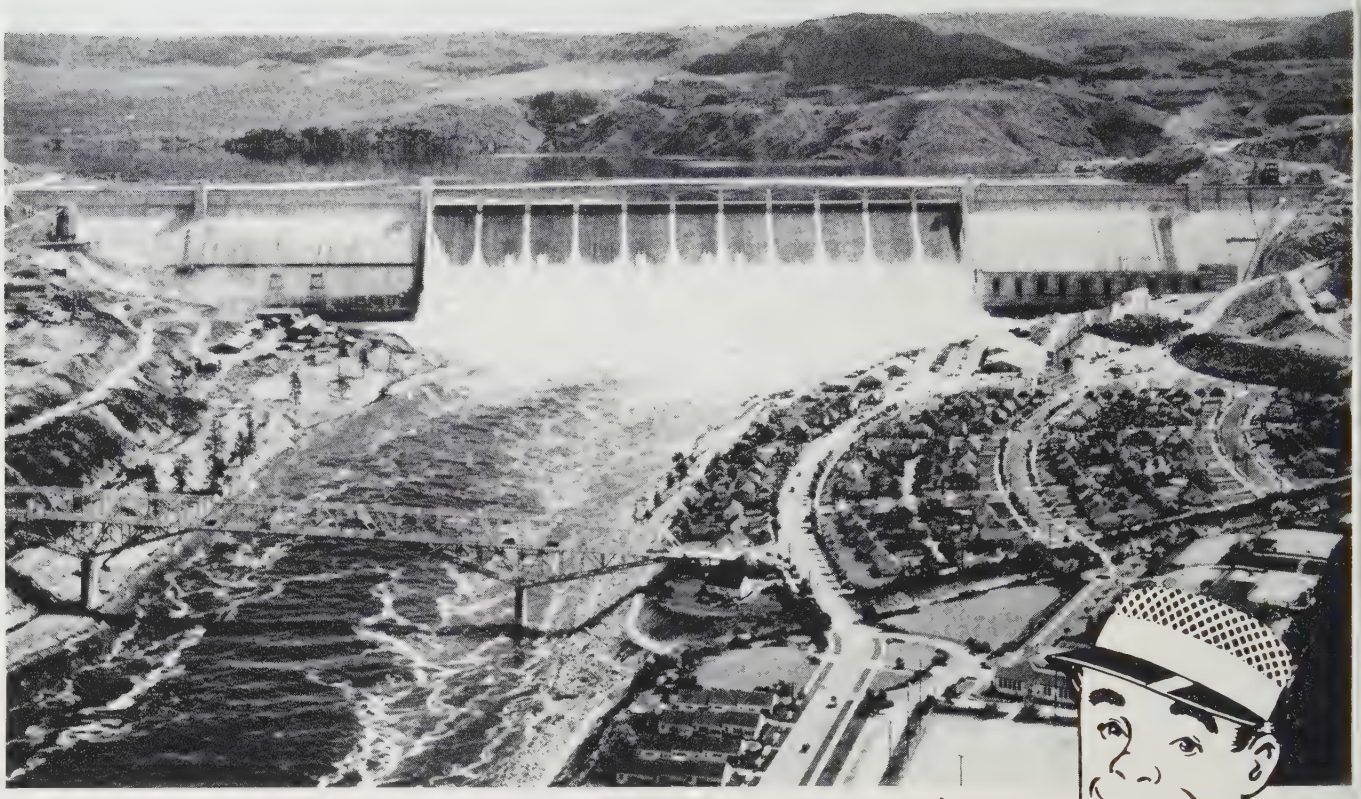
Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany

In Canada—Alchem Limited, Burlington, Ontario

THE *Nalco*® **SYSTEM . . . Serving the Paper Industry through Practical Applied Science**

*Idea suggested by G. H. Stevenson, Empire, Oregon

Photo of Grand Coulee Dam, Washington State by Ewing Galloway, N. Y.



"Reminds me of HAMILTON Felts... they're engineered for long service and fast water removal"

"The pumps at Grand Coulee Dam
can deliver—for irrigation purposes—
528,400,000 gallons of water per hour.
Hamilton Felts, too, are
engineered for fast water removal.
And each Hamilton Felt,
also like Grand Coulee Dam,
has been engineered
for long, trouble-free service.
That's why Hamilton Felts
beat the high cost of downtime
and keep your machines running
at top speed—longer."
If this is what you want your felts to do
why not talk it over with your
Hamilton Felt service salesman—soon?

YOU CAN'T BEAT

Hamilton

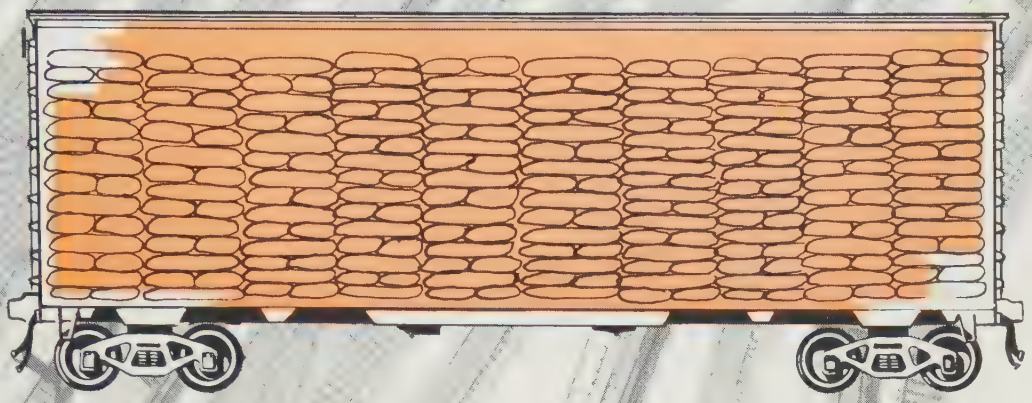
FELTS

*WIN... *A NEW Shakespeare Spincast Fishing Outfit!*

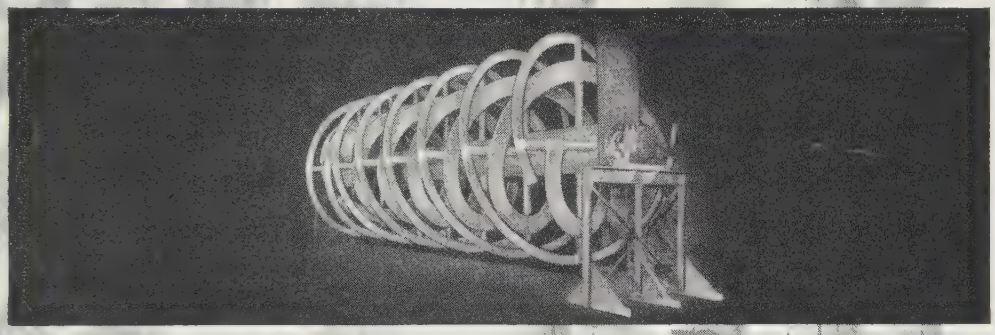
"What famous place reminds you of Hamilton Felts? Tell us why in a few words; sign your name and address and name of company. Each month, the idea from a papermaker that we use wins a new 1960 model Shakespeare Spincast Rod and Reel—FREE. When identical winning ideas are submitted by 2 or more papermakers, the one with the earliest postmark will be considered the winner. *Every papermaking entrant* receives a famous Rex Spoon fishing lure—FREE. Send me your suggestion—today. Ham Feltz, 612 First National Bank Bldg., Cincinnati 2, Ohio."

SHULER & BENNINGHOFEN, HAMILTON, OHIO

now you can have



starch uniformity by the carload



from the world's largest blender

New Penick & Ford Blender ensures production quantities at pilot plant tolerances

The big advantage of having your corn starches mixed in the world's largest blender is not size of batch, but the perfect starch uniformity you get . . . up to 60,000 lb. with one bag exactly the same as the next. The blender is part of Penick & Ford's new starch derivative plant which is designed to deliver corn products of improved quality and precise uniformity. With its new facility, P & F can offer industrial starch users production quantities to exact customer specifications, no matter how large or small the order. Call

PENICK & FORD, LTD.

INCORPORATED

750 THIRD AVE., NEW YORK 17, N. Y.; 1531 MARIETTA BLVD., ATLANTA, GA.; CEDAR RAPIDS, IOWA; 18 CALIFORNIA ST., SAN FRANCISCO 11, CALIF.

Jones Pulpers

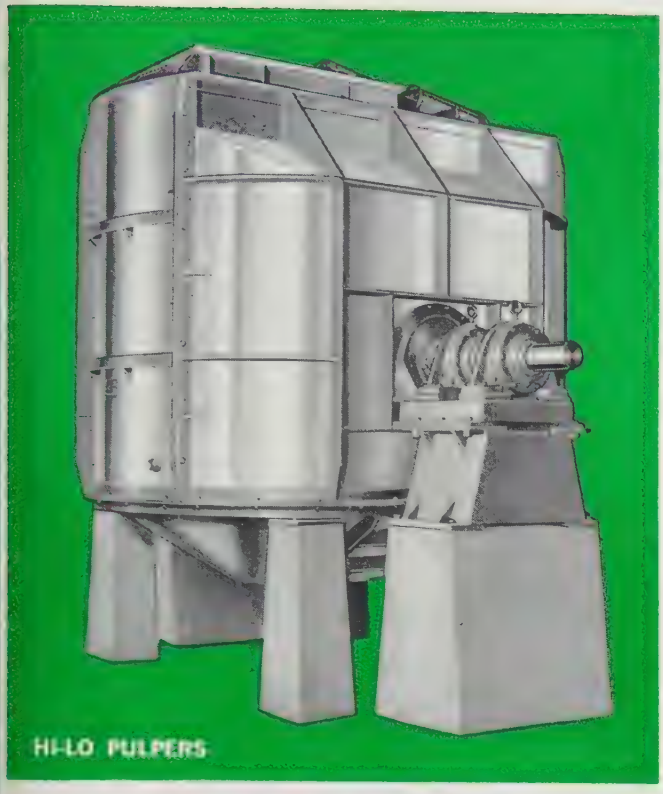
PICKED FOR PERFORMANCE IN THE NATION'S NEWEST MILLS

E. D. JONES CORP. · PITTSFIELD, MASS. · member BELOIT group

Canadian Associates:
The Alexander Fleck Ltd.
75 Spencer St., Ottawa

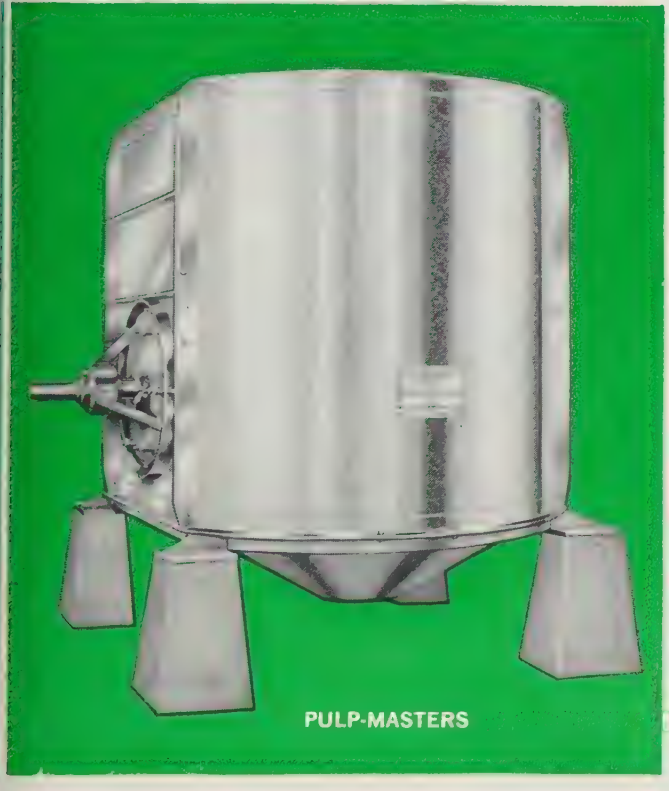
Jones

PULP MILL EQUIPMENT AND STOCK PREPARATION MACHINERY

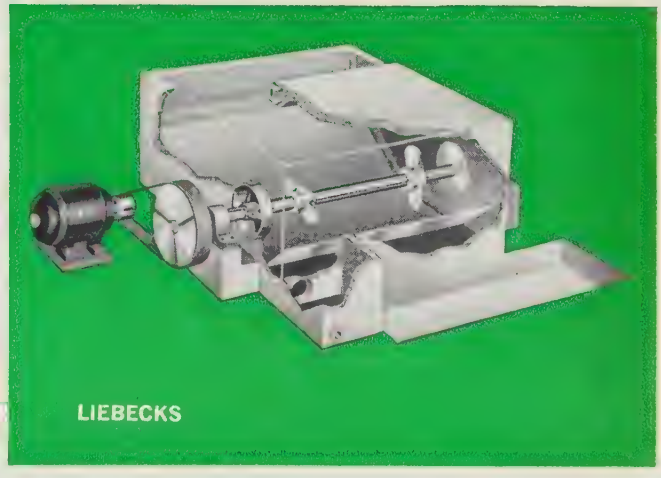


HI-LO PULPERS

TURBOFLEX — Latest addition to the line . . . proven by Fleck in mills throughout Canada and Europe . . . now built in the United States by Jones.

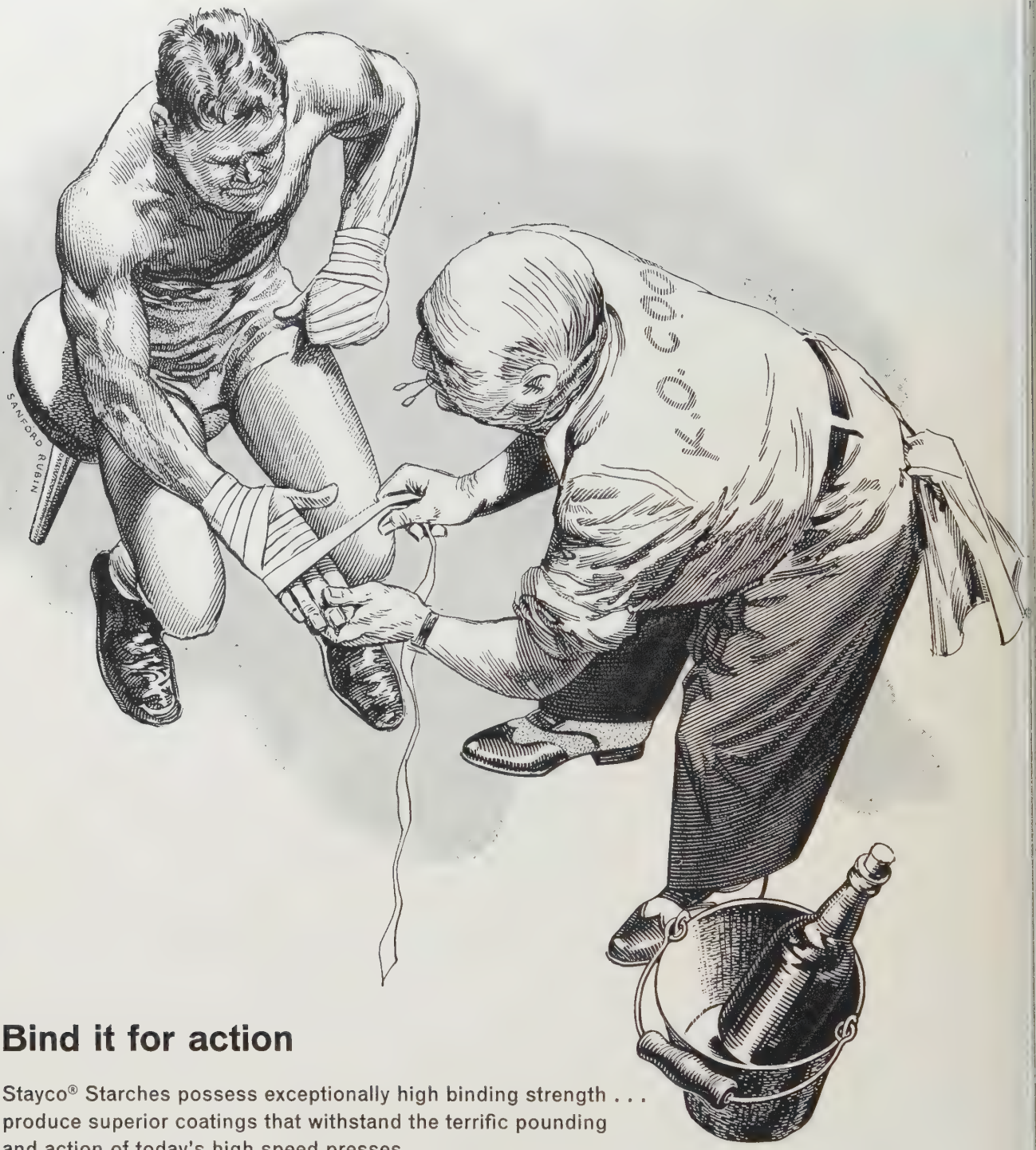


PULP-MASTERS



LIEBECKS

From coast to coast the managers of the country's most modern mills have chosen Jones equipment to handle their pulping needs — from initial slushing and defibering to broke repulping. Their reasons — *dependability*, *minimum downtime*, and the knowledge that Jones offers a *complete line* of pulping equipment. If you are thinking of modernizing, it will pay you to include Jones in your plans.



Bind it for action

Stayco® Starches possess exceptionally high binding strength . . . produce superior coatings that withstand the terrific pounding and action of today's high speed presses.

Optimum printability requires papers with coatings of highest adhesive quality . . . maximum binding strength. Stayco Starches improve pick resistance . . . increase internal bond and strength . . . produce superior coatings of low viscosity, high solids, excellent color and smoother printing surface to assure reproductions of eye-catching quality.

A. E. STALEY MFG. CO.
Decatur, Illinois

ATLANTA • BOSTON • CHICAGO • CLEVELAND • KANSAS CITY • NEW YORK • PHILADELPHIA • SAN FRANCISCO • ST. LOUIS

EC&M *Fuseless* AIR-BREAK STARTER

GIVES Certified

100/150 MVA FAULT PROTECTION

NO SINGLE PHASING FROM BLOWN FUSES!

NO COSTLY REPLACEMENT FUSES TO STOCK!

- ✓ Gang-operated Disconnect Switches Grounded for Safety in Open Position. Mechanically Interlocked with Contactor... Never Open Under Load
- ✓ No Fuses. Bus Bars Throughout
- ✓ 3-way Door Interlock. On, Off and Open—with Positive Interlocking between Door, Disconnect and Contactor for Maximum Personnel Protection
- ✓ Heavy-duty DC Operating Magnet. No Chatter—No Hum

FRONT ACCESSIBLE WITHOUT ROLL-OUT!

Phase barrier and arc-chutes slide out. All starter parts exposed and accessible for easy inspection and maintenance

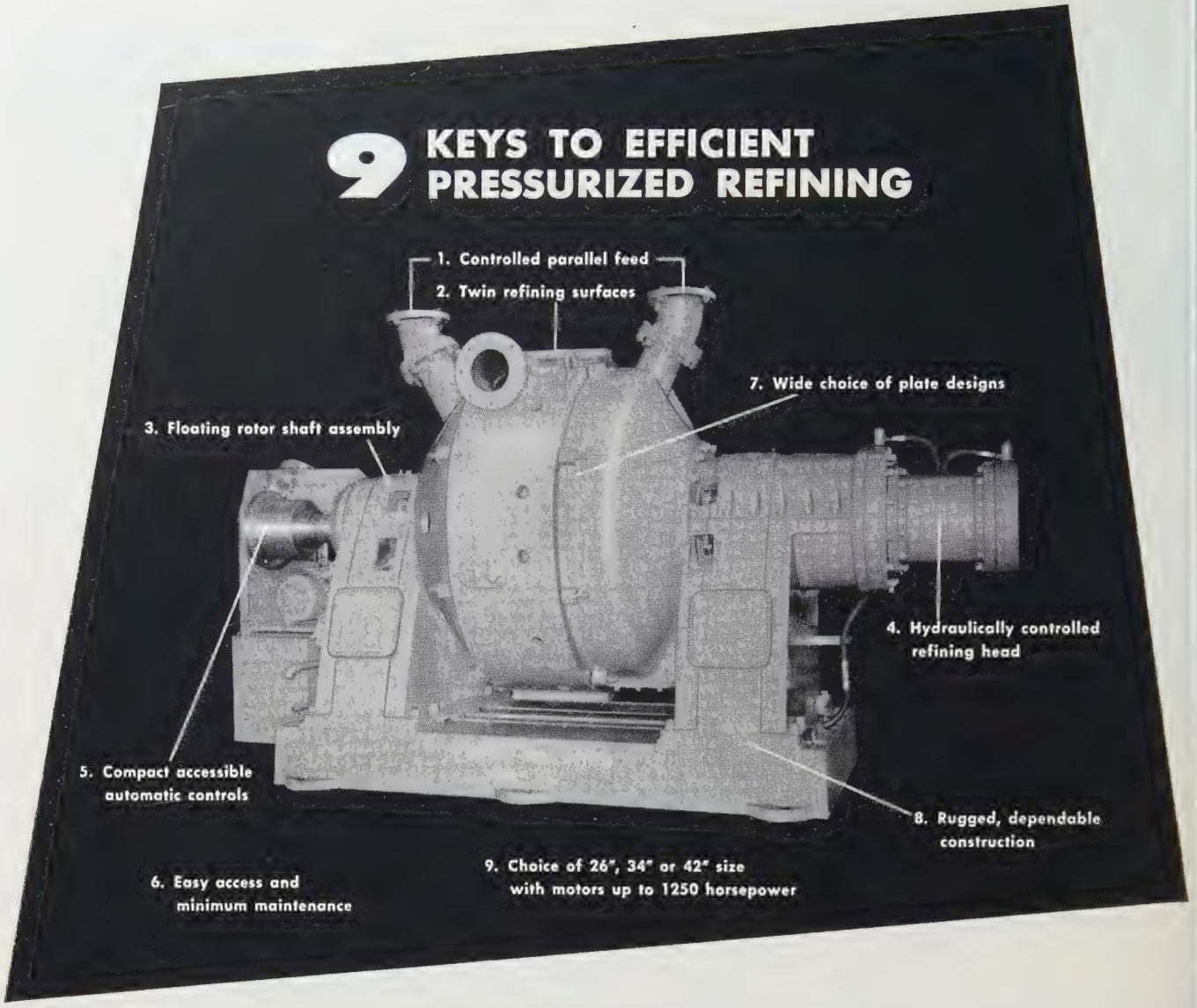
Get the complete story on certified fuseless fault protection for high-voltage motor drives. Write for Bulletin 8130A

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

wherever electricity is distributed and controlled

2635


9 KEYS TO EFFICIENT PRESSURIZED REFINING
1. Controlled parallel feed
2. Twin refining surfaces
3. Floating rotor shaft assembly
4. Hydraulically controlled refining head
5. Compact accessible automatic controls
6. Easy access and minimum maintenance
7. Wide choice of plate designs
8. Rugged, dependable construction
9. Choice of 26", 34" or 42" size with motors up to 1250 horsepower

SPROUT-WALDRON PRESSURIZED REFINER

twice the normal capacity in a single unit

Here is a new type stock preparation refiner designed for superior quality control, low operating costs and minimum maintenance. The parallel feed arrangement serves twin refining surfaces, giving twice the capacity of standard single disc units. Key to refining accuracy and dependability is the floating rotor shaft disc assembly which rotates between the fixed and hydraulically controlled movable heads. The flow of pulp is equally distributed between both sets of plates assuring uniform refining and even plate wear. If you are looking for mechanical simplicity, high production and uniform quality, plus low operating and maintenance costs, get the facts on the Sprout-Waldron 26", 34" and 42" pressurized refiners. Bulletins available on request.

SPROUT, WALDRON & CO., INC.

MUNCY, PENNSYLVANIA, U. S. A.

SINCE 1866 REFINERS • CONVEYORS • FEEDERS • SCREENS • MIXERS • DRAINERS • FIBER PRESSES • STOCK PROPORTIONERS

E/204

Letterpress with polish . . . on RHOPLEX coated pape

Talk about printing perfection . . . These apples need no polishing. They are printed on stock having a RHOPLEX all-acrylic emulsion as the pigment binder in the coating. All tones—highlights, halftones, deep hues—reproduce accurately, with brilliance, detail, and color fidelity that please even the most perfection-minded printers. Other reasons printers like RHOPLEX-coated stock: freedom from picking, good varnish holdout, uniform printing performance, and freedom from objectionable odor.

As a papermaker, you'll like the way RHOPLEX emulsions perform when you use them as binders in your coatings. You can use RHOPLEX for on- or off-machine coatings applied by trailing-blade, air-knife, or roller coaters. You can apply high-solids coatings at high speeds, because RHOPLEX formulations with solids as high as 65 percent can still have good handling viscosity. Under heat and pressure, RHOPLEX coatings level out and take on a high degree of gloss because the polymer in the binder is thermoplastic . . . something you don't get with coatings using natural binders.

For formulating information and technical data on the use of RHOPLEX B-15 and RHOPLEX B-60A in coatings for printing papers and paperboard, write for our 16-page booklet RHOPLEX *Acrylic Emulsions in Paper Coatings*.

Chemicals for Industry

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square, Philadelphia 5, Pa.

RHOPLEX *is a trademark, Reg. U.S. Pat. Off. and in principal foreig countries.*

RHOPLEX

IT'S A BETTER, BRIGHTER DAY WHEN YOU READ
The New York Times
SMART PEOPLE EVERYWHERE KEEP UP WITH THE TIMES
IT'S A BETTER, BRIGHTER DAY WHEN YOU READ
The New York Times
PEOPLE EVERYWHERE KEEP UP WITH THE TIME
The New York Times

TITANOX® helps make a good paper better

Don't misunderstand us. We're not claiming any credit for the editorial content of the New York Times, one of the world's great newspapers.

But we are proud that TITANOX titanium dioxide is being used to brighten the "rainy-day" bags that help the Times reach its subscribers in the most readable condition. It's this white titanium dioxide pigment that gives this waxed-paper stock the whiteness, brightness and opacity that makes the Times' advertising message stand out.

Because of their uniformity of all properties, TITANOX white pigments are always a favorite—not only for overcoming the transparency caused by waxing, but also for opacifying the highest grades of writing and printing papers. Whether added at the beater or in surface applications, TITANOX always makes a good paper better.

And as it is with paper, so it is with a wide range of other products...there is a TITANOX pigment for anything that needs whitening, brightening or opacifying. Titanium Pigment Corp., 111 Broadway, N.Y. 6, N.Y. In Canada: Canadian Titanium Pigments, Ltd., Montreal.

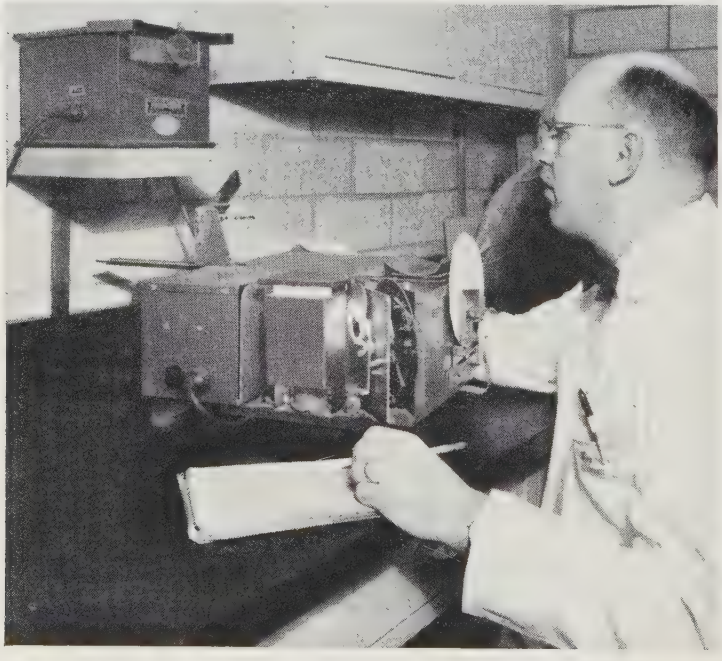
TITANIUM PIGMENT CORPORATION

SUBSIDIARY OF NATIONAL LEAD COMPANY

7823

U.S.I. SERVICES THE PAPER INDUSTRY WITH TECHNICAL LAB ASSISTANCE...

IN PACKAGING — From studies such as this test of heat seal strength, U.S.I.'s Polymer Service Laboratories develop recommended procedures for all aspects of polyethylene packaging.



IN PULPING — Tech Service Engineer at U.S.I.'s laboratory-scale pulp and paper "plant" determines brightness of a hand sheet he has made from customer's pulp, on Hunter Multipurpose Reflectometer. He will also test it for tensile and bursting strengths, folding resistance.

in pulping
in converting
in packaging

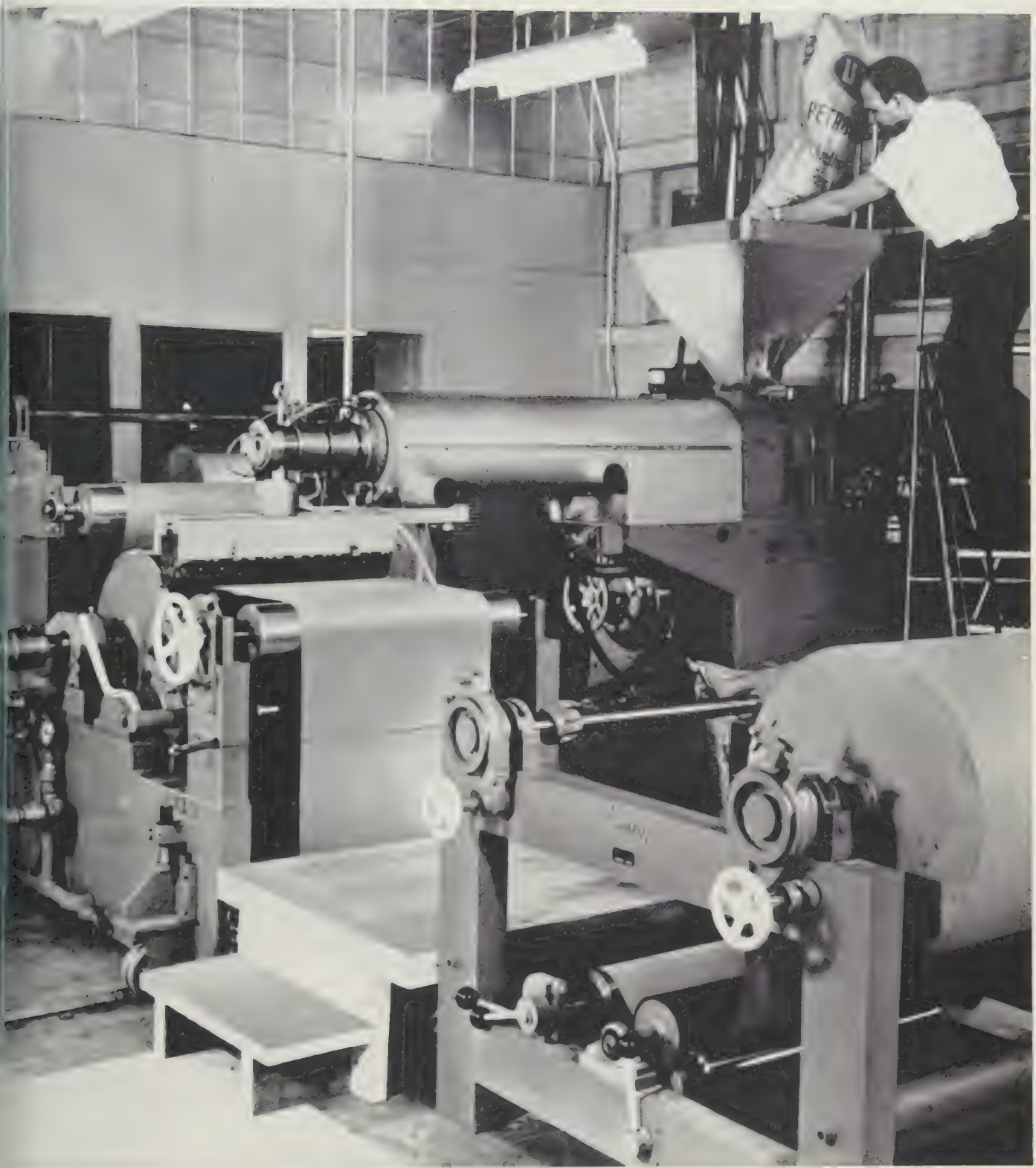
Whether you're pulping, converting or packaging paper products, U.S.I. has a laboratory and staff devoted to technical service in your field. Its job: to see that U.S.I. products for the paper industry give you the results you need in your operation.

U.S.I.'s pulp and paper laboratory — built eight years ago when U.S.I.'s Huntsville, Alabama, chlorine and caustic soda plant began operation — is a miniature paper plant, complete with auxiliary testing equipment. Here our engineers work on bleaching and assist with other applications of U.S.I.'s chlorine, caustic, ammonia, sodium peroxide . . . determine systems, techniques, types and concentrations of chemicals so that customers will know how to produce the brightest pulp with minimum fiber degradation.

Another lab at Tuscola, Illinois, is staffed with experts on polyethylene technology—including coating of paper and board, and packaging of paper products for the consumer market. They have equipment to duplicate commercial production and testing techniques . . . to tackle any problem involving an application for PETROTHENE® polyethylene resins.

A vital part of the Polymer Service Laboratories' work is development of new polyethylene paper coating and paper products packaging techniques along with design of necessary equipment.

Write or call for more information on how these services can work for you in improving your products . . . expanding your markets.



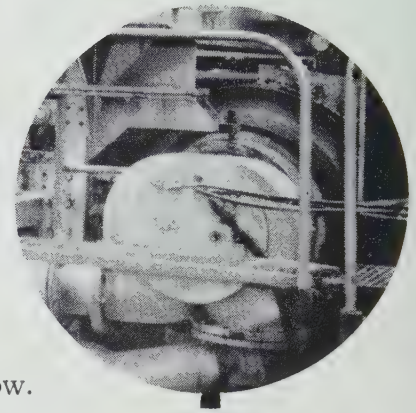
IN CONVERTING—Duplicating commercial equipment in everything but width, this coating machine at U.S.I.'s Polymer Service Laboratories is a key factor in developing new polyethylene resins for specific substrates. Latest products to come out of such work are three new PETROTHENE® resins designed for paper coating applications.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
Branches in principal cities

CHLORINE • CAUSTIC SODA • SODIUM PEROXIDE • AMMONIA • PETROTHENE® POLYETHYLENE

Now . . . your tissue machine can be made to run more profitably by easy conversion to a Rice Barton

Suction Breast Roll



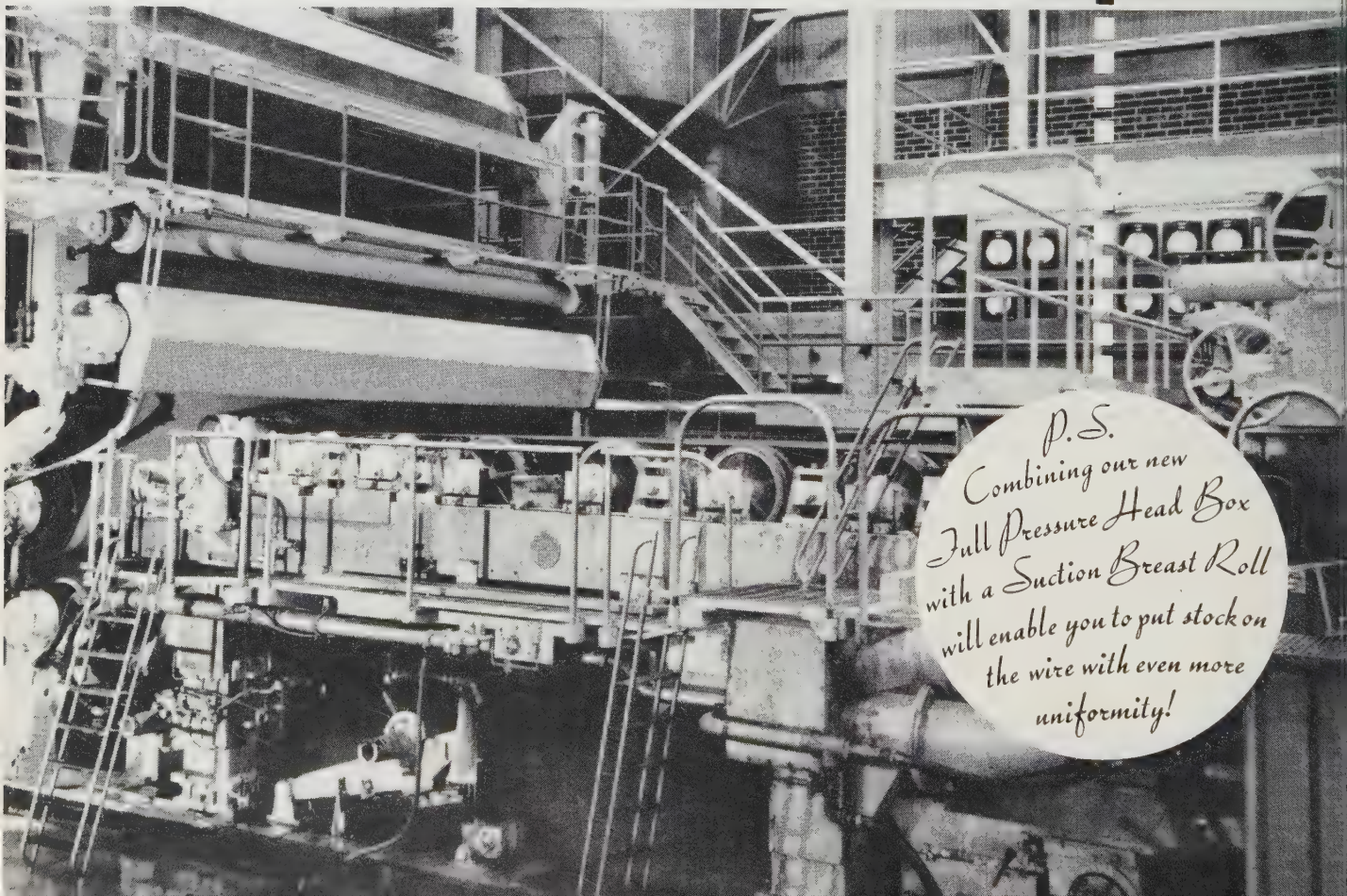
1. Easier, more predictable formation up to 3000 f. p. m.
2. Better control, more uniformity at any designed speed.
3. Bouncing eliminated, less fibre disturbance.
4. Shorter fourdrinier possible. Note short wire length below.

Another "first" from our drawing boards, and further proof of superior engineering that has made Rice Barton a leading paper machinery builder for 123 years. For more information on what these advantages can mean to you write

Rice Barton CORPORATION • WORCESTER, MASS.

FOURDRINIERS, PRESS SECTIONS, DRYER SECTIONS, CALENDERS AND SUPERCALENDERS, REELS, WINDERS, HEAD BOXES, SIZE PRESSES, BREAKER STACKS, DIFFERENTIAL DRAW CONTROL DRIVES AND CONE PULLEY DRIVES, PULPING EQUIPMENT, HIGH VELOCITY AIR DRYERS, TRAILING BLADE COATERS, FIBRE-FLASH DRYING SYSTEMS

RICE BARTON



P.S.
Combining our new Full Pressure Head Box with a Suction Breast Roll will enable you to put stock on the wire with even more uniformity!

They go hand in hand with more printable papers

GELVA® C-3 and C-5 polyvinyl acetate resins

GELVA C-3 and C-5 Copolymer Resins applied from ammonia solutions provide improved wet strength, surface erasability, ink receptivity, surface gloss and grease and abrasion resistance. Add to these . . . increased Mullen, wax pick, tensile and fold strength, plus easy broke recovery, and you have the reason for the rapidly increasing use of these products by the paper industry.

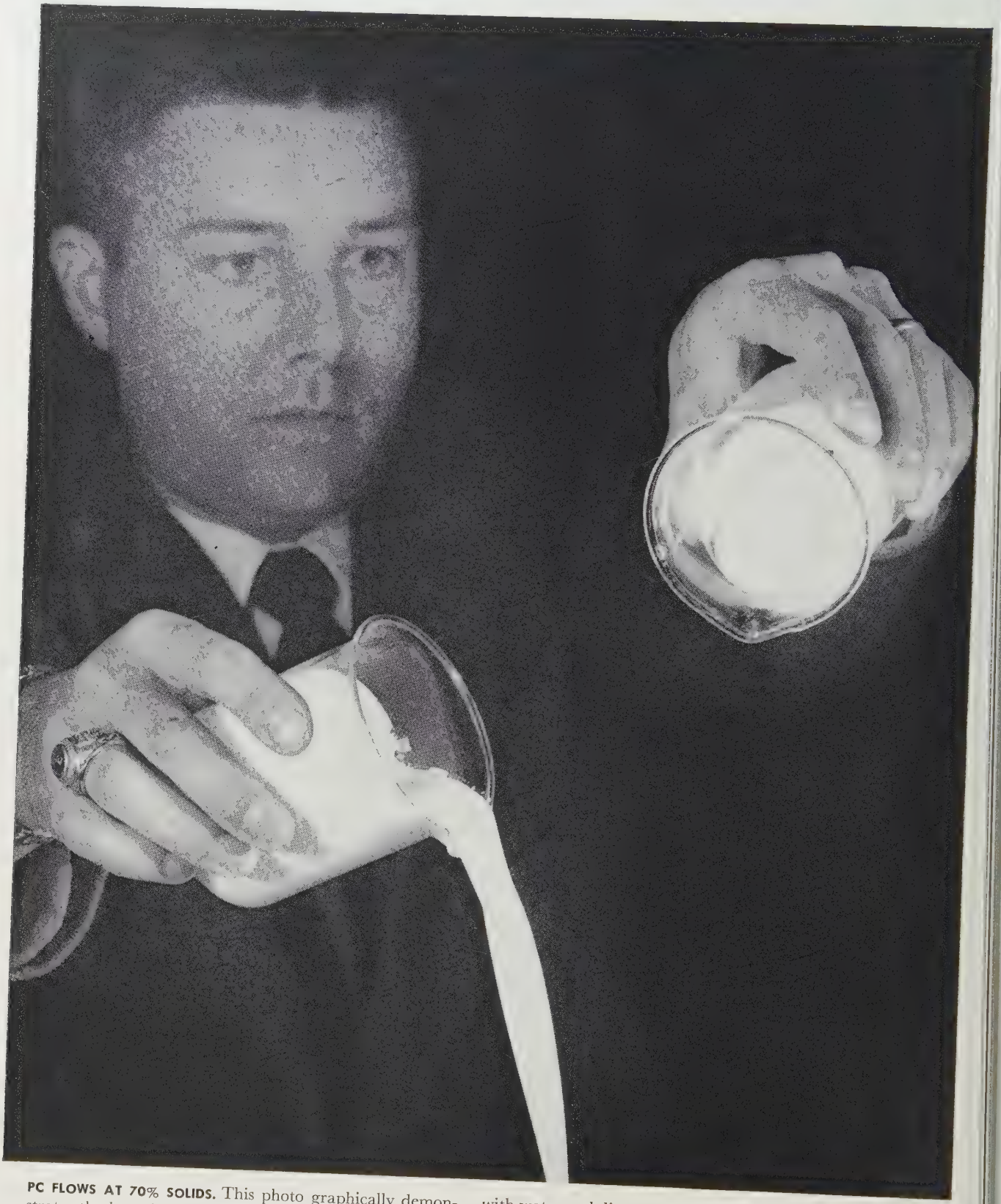
Coast-to-coast warehousing, Shawinigan's large staff of research chemists who are ready to help you with your particular problems, and highly trained field representatives add up to an organization that can help you improve your products and your profits. Write to Shawinigan Resins Corporation, Dept. SR, Springfield 1, Massachusetts.

SALES OFFICES: ATLANTA CHICAGO LOS ANGELES NEW YORK CLEVELAND SAN FRANCISCO GREENSBORO ST. LOUIS

GELVA® *polyvinyl acetate resins by* **SHAWINIGAN RESINS®**

FROM DU PONT RESEARCH . . .

The first Titanium Dioxide Pigment



PC FLOWS AT 70% SOLIDS. This photo graphically demonstrates the low viscosity of PC formulations. An ordinary anatase grade and new "TI-Pure" PC were each mixed with water and dispersant to 70% TiO_2 content by weight. When beakers are inverted, PC formulation (left) flows readily while other formulation remains almost a solid mass.

expressly designed for paper coating

TI-PURE® PC

produces high-opacity unwaxed coatings at lower cost than rutile TiO_2 grades

Now, for the first time, an anatase titanium dioxide pigment that parallels the performance of higher-priced rutile grades in coating unwaxed paper and paperboard. It's Du Pont "Ti-Pure" PC—the first titanium dioxide pigment ever developed expressly for paper coating.

"Ti-Pure" PC offers the dry opacity of commonly used rutile grades . . .produces smooth coatings of slightly better brightness at lower cost. Its fade resistance in colored coatings is superior to other anatase grades and approaches that of rutile.

Excellent Viscosity Characteristics

At all pigmentation levels, PC yields viscosities comparable to rutile grades—and much lower viscosities than anatase grades commonly used in paper coating. Tests show that PC dispersions at 70% TiO_2 content by weight still flow at room temperature. (See photo).

RESULT: SUPERIOR WORKING PROPERTIES, heavier coating weights, higher machine speeds—all at less pigment cost than with a coating-grade rutile pigment. Your Du Pont Pigments Representative will gladly give you full details about "Ti-Pure" PC. Call or write him today.

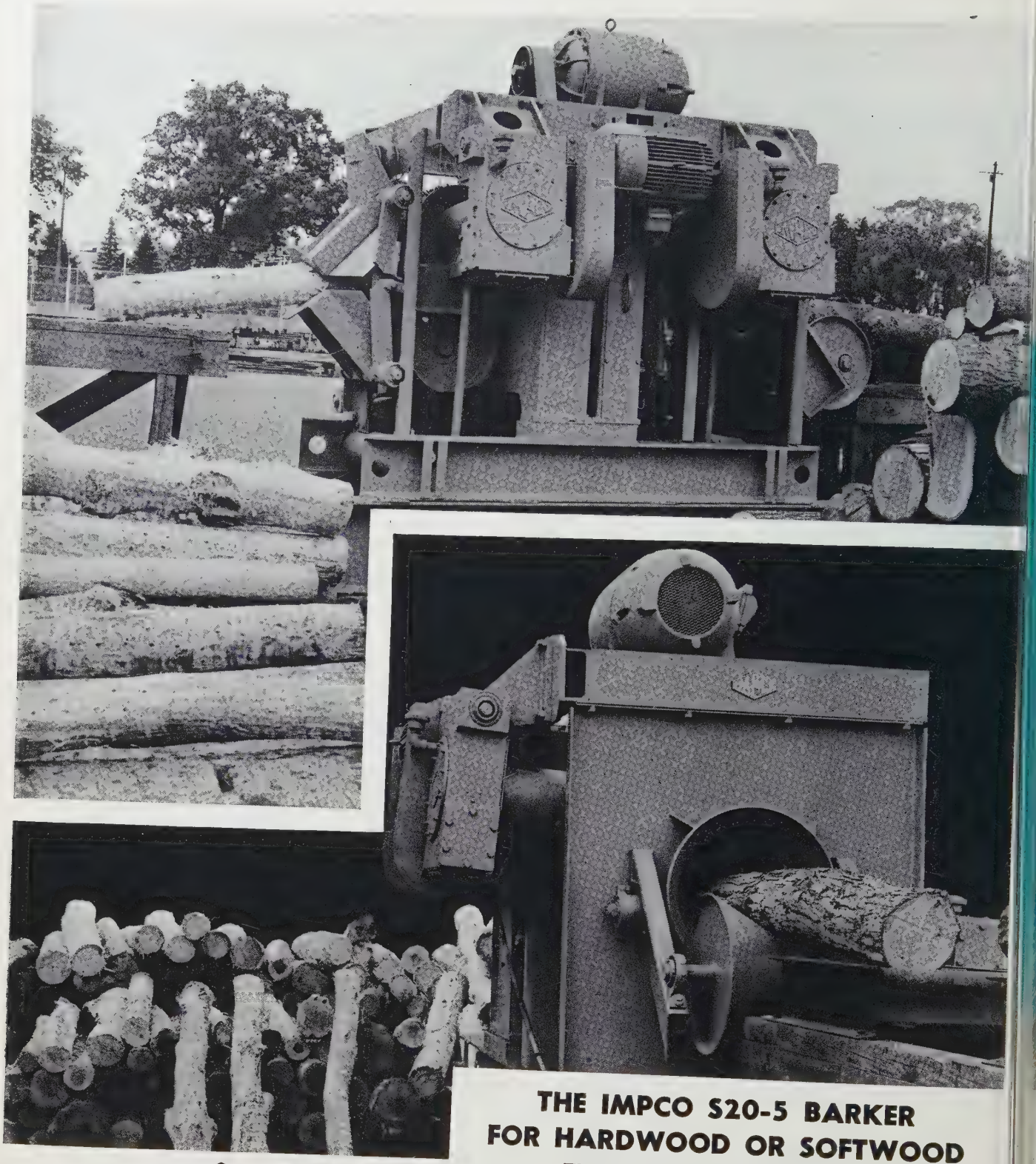
E. I. du Pont de Nemours & Co. (Inc)., Pigments Department, Wilmington 98, Delaware. *In Canada:* Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

TI-PURE® PC

(Titanium Dioxide Pigment)

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY



IMPCO®

IMPROVED
MACHINERY INC.
NASHUA, NEW HAMPSHIRE

In Canada:
Sherbrooke Machineries Limited
Sherbrooke, Quebec

THE IMPCO S20-5 BARKER FOR HARDWOOD OR SOFTWOOD FROZEN OR CROOKED!

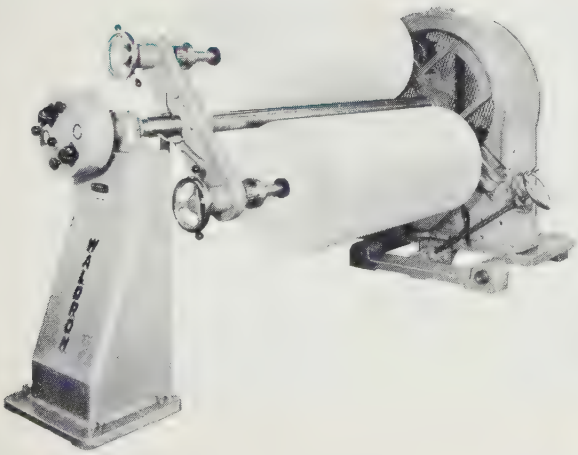
The S20-5 delivers a dependable high annual production rate of cleanly barked logs at very low maintenance and operating costs. This dependability, due to its extra-rugged design, is maintained with frozen crooked hardwood. Present installations average 250 cords/day with reported maintenance costs of 3 to 4 cents/cord, on logs in the 3″ to 19″ diameter range, down to 5′ in length.

TURN A REEL

A SERIES OF ADVANCED DESIGN UNWINDS & WINDS

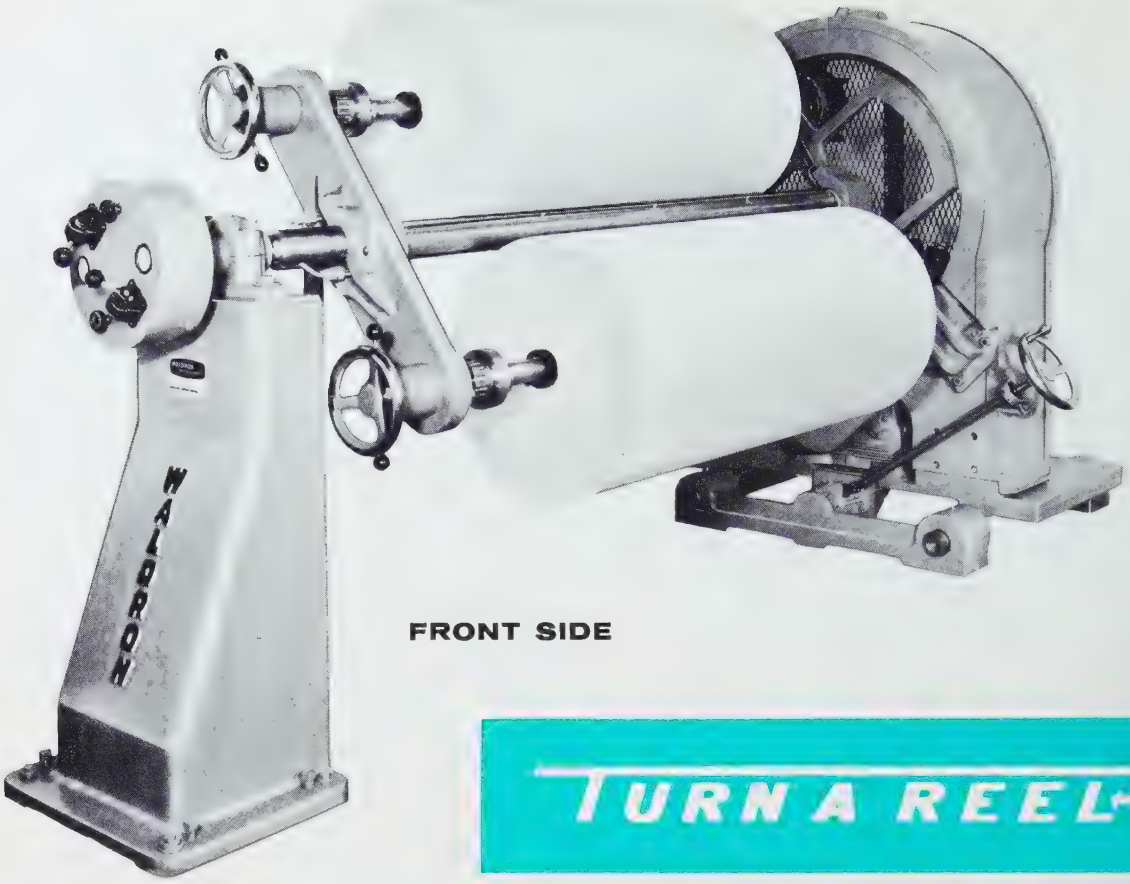
WINDS

UNWINDS



WALDRON

BULLETIN M-601



FRONT SIDE

TURN A REEL

APPLICATION:

For unwinding web materials such as paper, foil, film board and fabrics continuously — under controlled tension — without stops for roll changes — used on various types of web processing operations such as coating, laminating, printing — available in models for web widths to 108", roll diameters 18" to 42", and speed of operation up to 2000 fpm. On page 6 is a chart showing a series of standard unwinds selected especially for the particular roll diameter and width required.

OPERATING FEATURES:

Means of splicing continuously at modest speeds, with a full line of auxiliary equipment for either partly automated or fully automated flying splices at high speeds.

Simplicity in loading stock rolls from the floor, from fork truck, or hoist. Rapid lockup of rolls into the reel for either full width shaftless or shafted operation for varying widths.

Remote air-operated web tension control system on each individual roll; tension range selected for the particular application.

Reel rotation is push button controlled through an electric gear motor furnished as standard equipment.

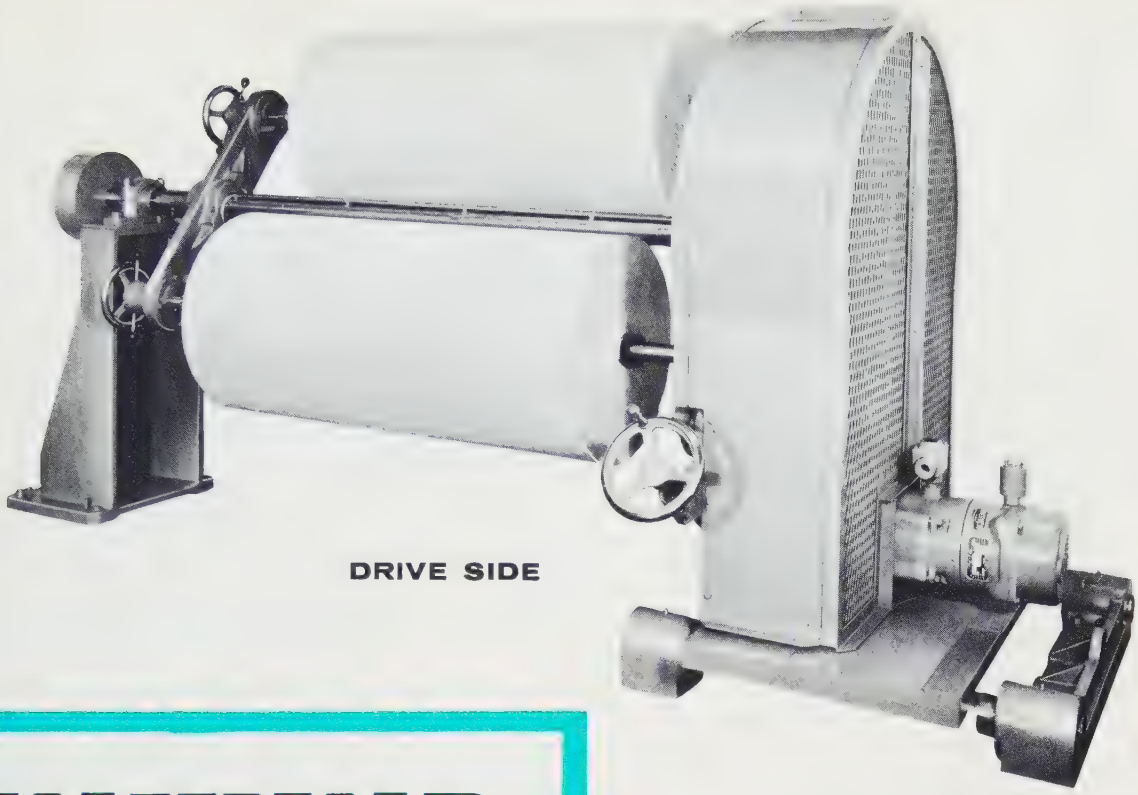
Sidelay control for running adjustment of web alignment; hand or automatically operated, and suited to the addition of automatic web guide steering equipment.

Reel is fully accessible and has good visibility of all operating equipment.

All moving mechanical parts are fully guarded.

FOR CONTINUOUS UNWINDING

COPYRIGHT 1960 MALDROP CORPORATION



DRIVE SIDE

UNWIND

MECHANICAL FEATURES:

Structurally stable, heavy cast iron construction.

The design is standard and built with the ability to add optional features at any later time.

Ball bearing construction in each spindle for minimum frictional effect on the tension control system.

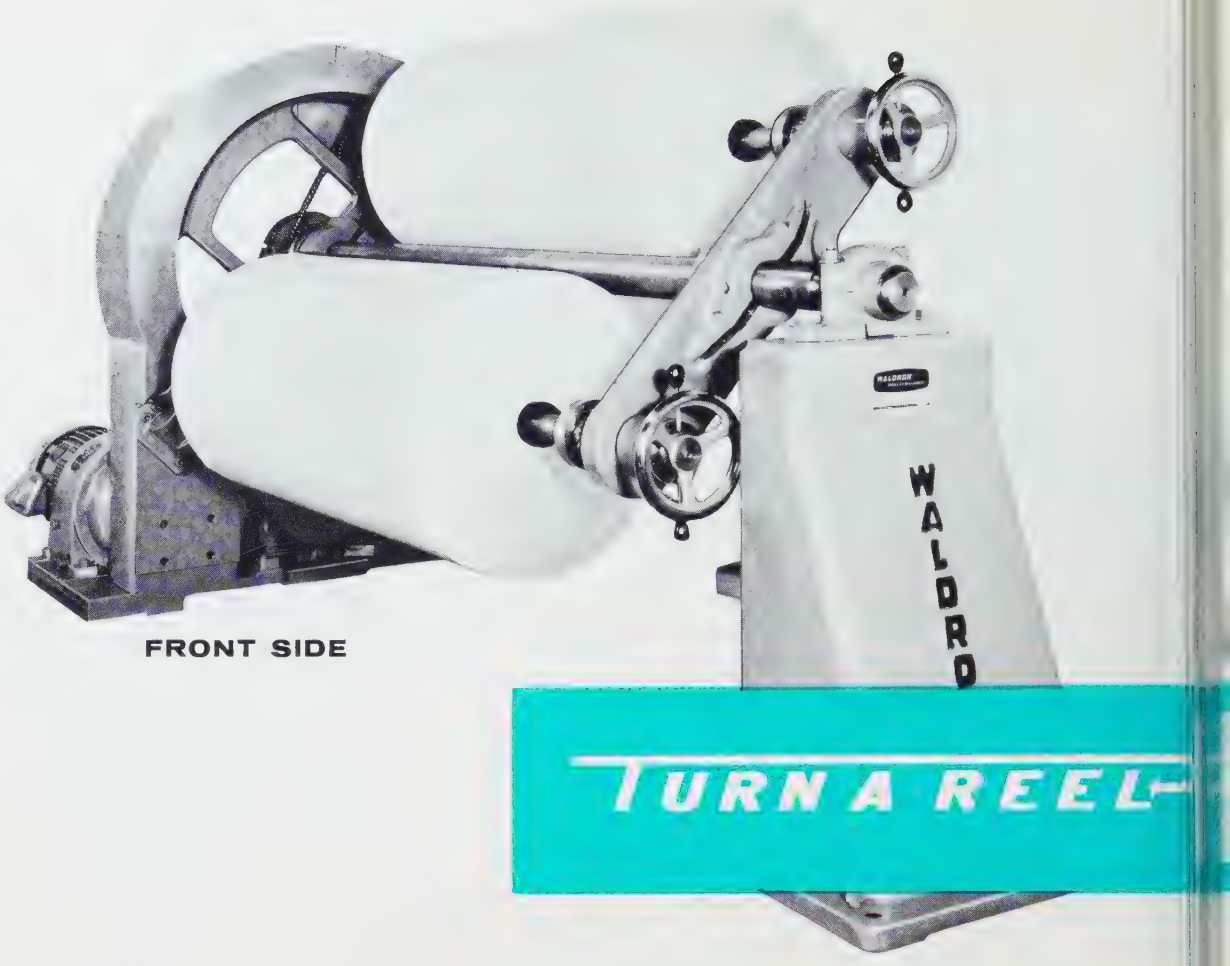
Quick shaft or core lockup with auxiliary lock for added safety.

Solid large diameter steel mainshaft to keep arms parallel at all times and prevent web wrinkling.

AC Gearmotor to rotate the reel, equipped with electric brake for positive stops of the reel in desired position without coasting.

OPTIONAL EQUIPMENT:

1. Constant tension automatically regulated control devices.
2. Automatic web steering and alignment control.
3. Semi-automatic and fully automatic auxiliary web splicing devices as suits the particular requirement.
4. Roll shafts of various types such as expanding shafts, and/or expanding chucks.
5. Auxiliary idler and squaring rolls, depending on the web lead required for the next processing operation.



FRONT SIDE

APPLICATION

For centerwinding web materials such as paper, foil, film, board and fabrics continuously — under controlled tension with the particular drive and tension characteristics suited to the particular process — makes flying starts for roll changes on processing operations such as coating, laminating, extruding, or printing — on web widths up to 108 inches, roll diameter from 18" to 42", and speed of operation up to 2000 fpm.

On page 7 is a chart showing a series of standard winds selected especially for the particular roll diameter and width required.

OPERATING FEATURES:

Centerwinding with winding power sources suited to the individual job to be done.

Constant torque, constant tension, or taper tension winding available for either manual or automatic regulation.

Flying starts can be made at modest speeds without auxiliary equipment, or with auxiliary equipment that can be furnished for full speed automated flying starts up to 2000 fpm using the new "Waldron Method" for high speed flying starts.

Quick lockup of cores and quick release; either to hoist or dolly for unloading.

Full accessibility and good visibility under operating conditions.

FOR CONTINUOUS WINDING OF

DRIVE SIDE

WIND

MECHANICAL FEATURES:

The wind is designed of heavy cast iron construction, many parts of which are common with the unwind for interchangeability of parts and reduction in requirement of spares.

Standard design permits addition of optional features at anytime in the future.

Ball bearing construction in each spindle reduces the frictional effect of the spindle to a minimum. Ball bearing construction is also used throughout the drive system for minimum frictional drag of the drive as it might affect tension control.

Solid large diameter steel mainshaft to keep arms parallel and prevent wrinkling.

AC gearmotor to rotate reel, equipped with electric brake for positive stops of the reel in desired position without coasting.

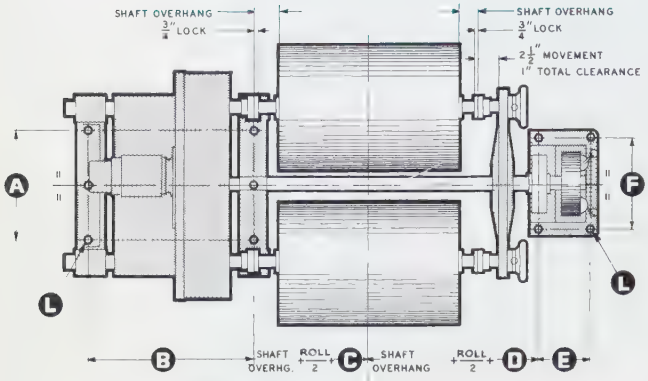
Fully guarded and ventilated.

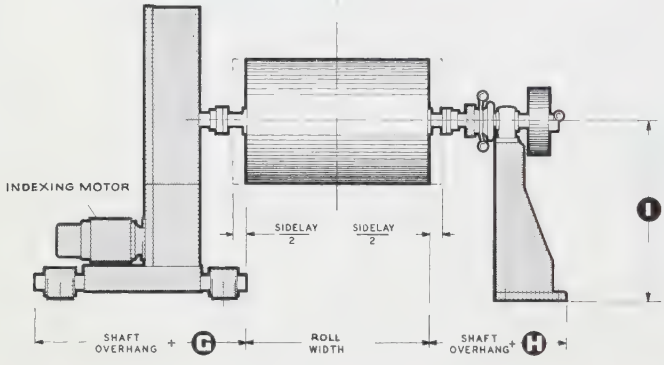
OPTIONAL EQUIPMENT:

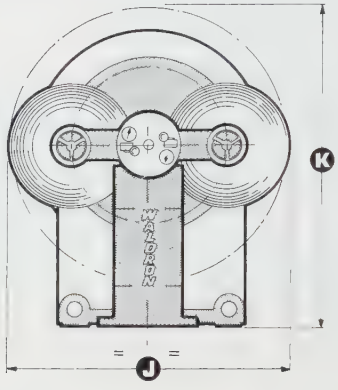
1. Flying starts for continuous operation either manually, or with additional auxiliary equipment for fully automated flying starts up to 2000 fpm. Several stages of automation are available, depending on the particular job to be done.
2. The new "Waldron Method" of flying starts is available for better starts over a full speed range on materials from light weight paper to board.
3. Auxiliary rolls, such as squaring rolls, pressure rolls and expanding rolls can be supplied for web control, depending on the particular process requirements.
4. Tension controls suited to the job, such as fully automatic, constant tension, taper tension, or constant torque can be provided.
5. Roll shafts of various types such as expanding shafts, and/or expanding chucks.
6. Side shifting: while it is not customary to provide winds with side shift equipment, there are some processes such as film winding where automatic side shifting or oscillation of the winder is required and it is available.
7. Trim slitting devices ahead of the wind such as score, shear or razor blade.

TURN A REEL UNWINDS

SERIES			1800	2400	3000	3600	4200
MAX. ROLL DIA. "			18"	24"	30"	36"	42"
MAX. ROLL WIDTH "			84	96	96	108	108
MAX. ROLL WEIGHT			2750	2100	2600	4400	5150
MAX. REQ. AIR P.S.I.			75	75	75	75	75
INDEX MOTOR H.P.			.5	.5	.75	1.5	2
UNIT NET WT.			3500	4000	4500	5000	5500
MAX. SIDELAY			3 | —	3 | —	3 | —	3 | —	3 | —
DIMENSIONS WITH SIDELAY	DIMENSIONS WITHOUT SIDELAY (BASE AS WINDS OF CORRESPONDING SIZES)	A	28 | 36	28 | 36	28 | 36	34 | 46	34 | 46
		B	35½ | 16	35½ | 16	35½ | 16	35½ | 38	35½ | 38
		C	1 | 10¾	1 | 10¾	1 | 10¾	1 | 11	1 | 11
		D	17½	17½	17½	17½	17½
		E	14½	14½	14½	14½	14½
		F	20	20	20	20	20
		G	43 | 26	43 | 26	43 | 26	43 | 51	43 | 51
		H	35 | 33½	35 | 33½	35 | 33½	35 | 33½	35 | 33½
		I	39 | 34	42⅜ | 37⅜	45⅜ | 40⅜	56 | 49¾	60⅜ | 52⅞
		J	41	54	66	79	91
		K	64½ | 59½	69½ | 64½	78½ | 73½	95½ | 89	106 | 98½
FLOOR BOLTS		L	(8)-⅞	(8)-⅞	(8)-⅞	(10)-⅞	(10)-⅞

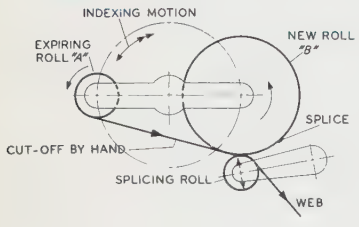






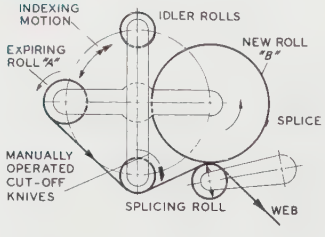
METHODS OF SPLICING—UNWINDS

1 MANUAL



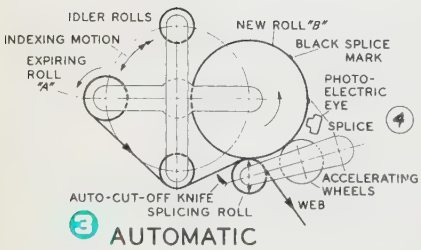
1. "B" indexed to position shown.
2. Operator turns "B" by hand.
3. Splicing roll raised.
4. Splice made, operator cuts expiring web by hand.
5. Core removed, new roll loaded.
6. Splicing up to 500 fpm.

2 SEMI-AUTOMATIC



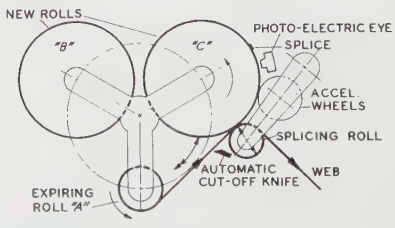
1. "B" indexed to position shown.
2. Motor drive to splicing roll started and roll raised.
3. Splice made, expiring web cut by pneumatic cylinder actuated knife.
4. Core removed, new roll loaded.
5. Splicing up to 500 fpm.

3 AUTOMATIC



1. "B" indexed to position shown.
2. Splicing assembly raised and motor to accelerating wheels started.
3. Splice made when surface of "B" up to line speed. Photo-electric eye detection on black mark operates splicing action.
4. Core removed, new roll loaded.
5. Splicing up to 2000 fpm.

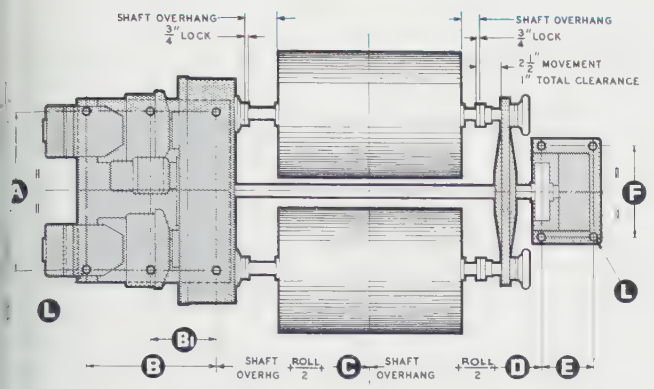
4 AUTO-3-SPINDLE

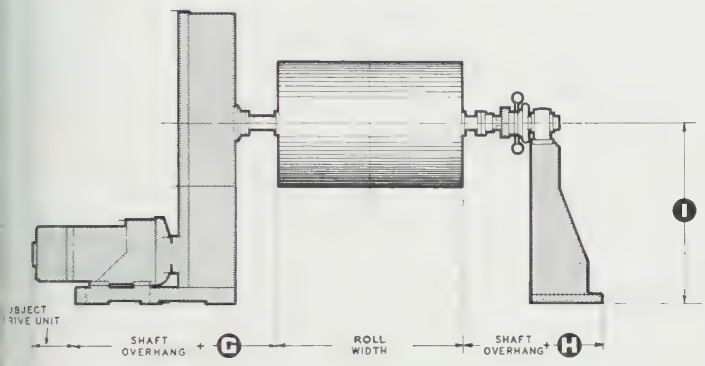


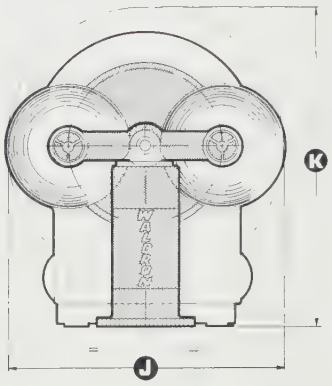
1. "C" indexed to position shown.
2. Splicing assembly raised and motor to accelerating wheels started.
3. Splice made when surface of "C" up to line speed. Photo-electric eye detection on black mark operates splicing action.
4. Core removed, new roll loaded.
5. Splicing up to 2000 fpm.

TURN A REEL WINDS

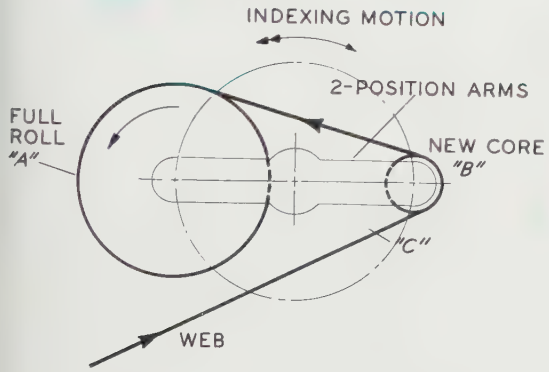
SERIES		1800	2400	3000	3600	4200
MAX. ROLL DIA. "		18	24	30	36	42
MAX ROLL WIDTH "		84	96	96	108	108
MAX. ROLL WEIGHT		2750	2100	2600	4400	5150
MAX. REQ. AIR P.S.I.		75	75	75	75	75
INDEX MOTOR H.P.		.5	.5	.75	1.5	2
UNIT NET WT.		3500	4000	4500	5000	5500
DIMENSIONS OF UNIT	A	36	36	36	46	46
	B	16	16	16	38	38
	B1	—	—	—	18¾	18¾
	C	10¾	10¾	10¾	11	11
	D	17½	17½	17½	17½	17½
	E	14½	14½	14½	14½	14½
	F	20	20	20	20	20
	G	26	26	26	51	51
	H	33½	33½	33½	33½	33½
	I	34	37⅜	40⅜	49¾	52⅞
	J	41	54	66	79	91
	K	59½	64½	73½	89	98½
FLOOR BOLTS	L	(8)-⅞	(8)-⅞	(8)-⅞	(10)-⅞	(10)-⅞



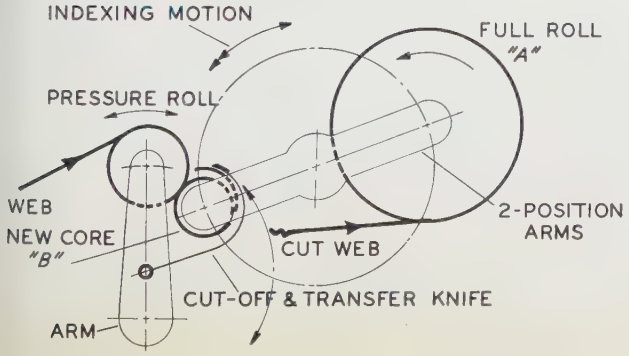




1 MANUAL



2 AUTOMATIC



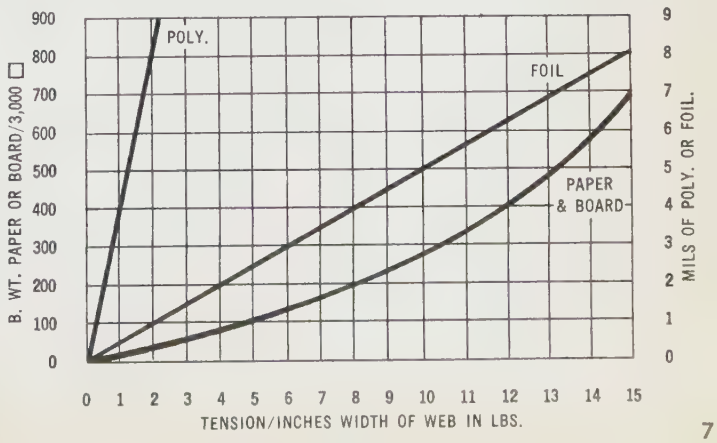
METHODS OF SPLICING–WINDS

1

1. Operator adjusts machine drive for drive used.
   a. 2 D.C. motors—drive—put on "B" to match core surface speed to web speed.
   b. 1 D.C. motor and 2 air clutches—clutch "A" slips, "B" matches under speed control.
   c. 1 A.C. motor and 2 air clutches—clutch "A" slips, "B" matches by sprocket ratio.
   d. Line shaft drive and 2 air clutches—clutch "A" slips, "B" matches by sprocket ratio.
2. "B" indexed to position shown.
3. Operator cuts web at "C" diagonally and wraps web around new core by hand.
4. Drive to "A" is stopped.
5. Full reel "A" removed and new core loaded.
6. Roll changing. Up to 500 fpm.

2

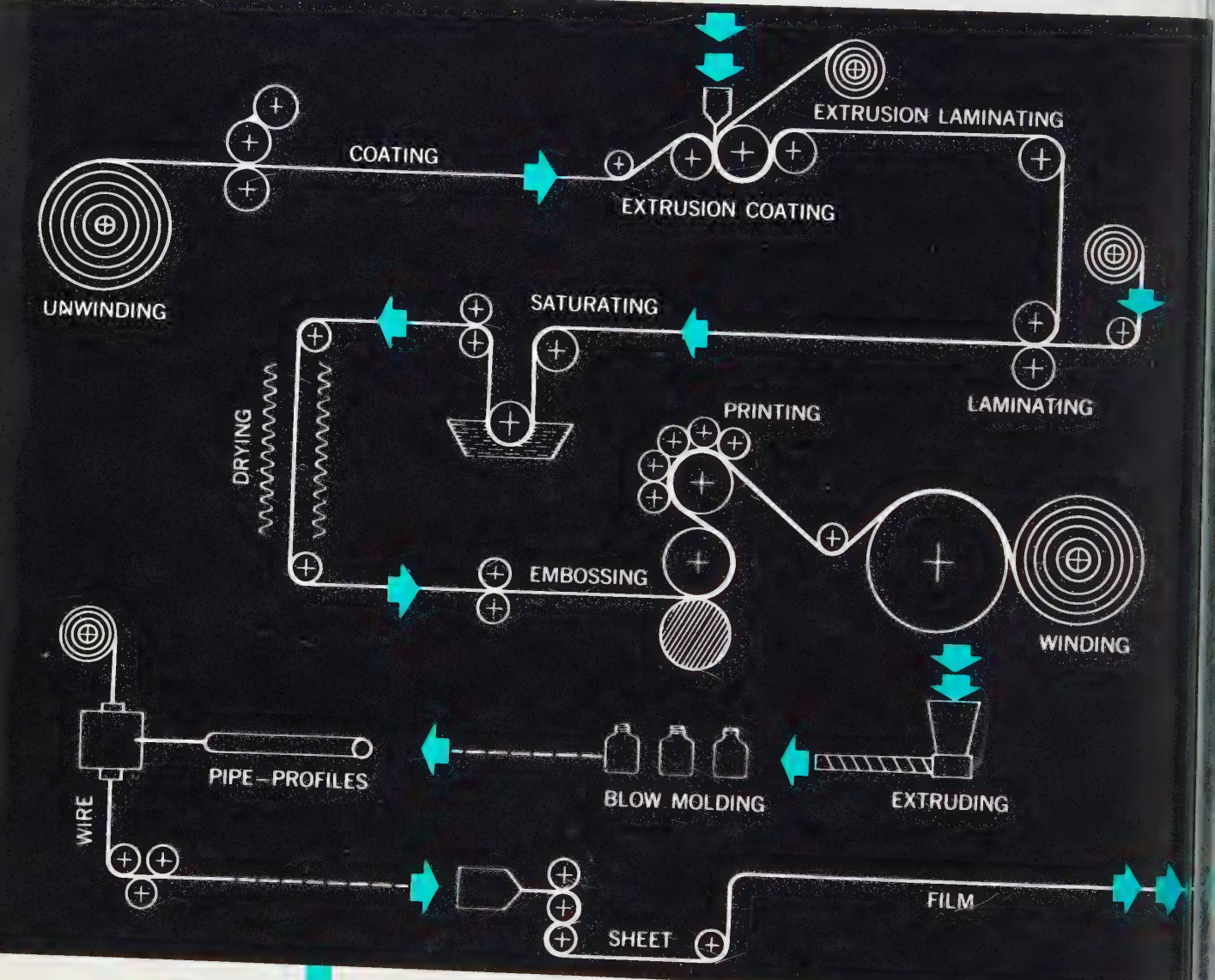
1. Operator presses "Paste" push-button.
2. Second motor matches speed of core with web speed.
3. Reel indexed to position shown.
4. Operator presses knife "cut" push-button, web transfers to core "B."
5. Knife action stops motor to "A."
6. Full reel "A" removed, new core loaded.
7. Roll changing. Up to 2000 fpm.



OTHER PROCESSING MACHINERY BUILT BY WALDRON-HARTIG

technical competence in web process machiner

PAPER · BOARD · FABRICS · FOIL · FILM · PLASTICS · METAL STR



WALDRON-HARTIG DIVISION
Midland-Ross Corporation

P. O. Box 791
New Brunswick, N. J.

Telephone CHarter 7-3100

Offices:

WALDRON-HARTIG DIVISION
Midland-Ross Corporation
320 S. School Street
Mt. Prospect, Illinois

Telephone—CLearbrook 3-5300

ROSS ENGINEERING OF CANADA, LTD.
Div. Midland-Ross Corporation
1669 Eglinton Avenue West
Toronto 10, Canada

Telephone—DOminic 6-5160

BOJANOWER MACHINERY SERVICE CO.
5270 East Washington Blvd
Los Angeles 22, California

ED IN U.S.A.

Studies on Slime Accumulations in Pulp and Paper Mills

IV. Fungal Floras of Slime Accumulations

D. BREWER

At a given location in a pulp and paper mill, the species of fungi present in an accumulation of slime may vary from sampling to sampling. These changes may be associated with a change in temperature, or in the fungicide used in the mill, but marked differences have been observed when the conditions appeared to be the same. Furthermore, at two different locations in the same mill, the fungal floras have been very different, although the temperatures were identical. Temperature and fungicide are not, therefore, the only factors influencing the composition of slime. Other factors in the physical environment, the availability of nutrients and the presence of stimulatory substances must also be recognized. The possible effects of variability of species, and of the presence of bacteria are discussed.

A PREVIOUS paper has described some of the fungi isolated from slime accumulations in pulp and paper mills in New Brunswick and Newfoundland (*1*). The purpose of this report is to show that the species of fungi present in a slime at a given mill can vary from sampling to sampling, and from location to location. In many instances, the differences observed could be correlated with differences in temperature, or with changes in the fungicide used in the mill, but sometimes, under apparently the same conditions, the fungal floras were very different. Not all fungal floras changed from one sampling to another, even though there had been a great change in the temperature. No attempt will be made to assess the relative importance of the different species in the formation of the slime, though the accumulations under consideration were all predominantly fungal in nature.

RESULTS

The methods of collection and isolation were as previously described (*1*). In the course of the survey of fungi associated with slime formation, the majority of the organisms isolated were members of the Moniliales, and of these the genus *Phialophora* was apparently the most widespread. Numerous isolations were made of organisms with a *Cephalosporium* type of spore production, some of which showed indications of having a perfect stage. In these cases, immature fruit bodies were produced in culture, but they never matured sufficiently for identification. Likewise, some of the isolates with a *Phialophora* type of spore production have produced immature fruit bodies in culture. A few species of the Sphaeropsidales and one of the Melanconiales have been isolated from slime. Occasionally a member of the Mucorales occurred on the dilution plates and one Ascomycete has been isolated.

Location 1. The first sampling of the slime accumulating in the groundwood system of a mill in New Brunswick was in June, 1956, and the temperature at this location was 15°C. The following fungi were isolated: *Cephalosporium* sp., *Phialophora fastigiata*, and *Phialophora* sp.

In November, 1957, another sample was collected from the same location. At the time of the collection of this sample the temperature of the system was 21°C. The dilution plates contained the following fungi: *Nodulisporium* sp., *Phialophora richardsiae*, *Rhinocladiella atrovirens*, and *Torula chartarum*. The dilution plates made from this sample yielded colonies almost exclusively of *R. atrovirens*, with only occasional colonies of the other organisms.

Shortly after this second sampling, the fungicide employed in the mill was changed and within a very short time the slime had changed from a dark mottled paste to a "tapioca-like" type. A microscopic examination of this slime showed that most of it was composed of fungal mycelium and spores, which belonged almost entirely to one species. Dilution plates made from this sample were rapidly covered by a very fast growing fungus, *Geotrichum* sp., accompanied very occasionally by colonies of another species. The change in the fungicide had completely eliminated *Rhinocladiella atrovirens*, the predominant species on the dilution plates from the previous sample.

In October, 1958, the slime accumulating in this groundwood system was again sampled. The fungicide in use in the mill was different, and the temperature at this point was 15°C. The fungi obtained from this sample were: *Phialophora lignicola*, *Phialophora richardsiae*, *Phialophora* sp., and *Rhinocladiella atrovirens*.

Location 2. In the kraft system of the same mill as Location 1, in 1956, a small amount of slime was accumulating in the tailing trough at a temperature of 5°C. This slime did not contain very much fungal material, but the following fungi were isolated: *Penicillium* spp., *Trichoderma lignorum*, and *Truncatella ramulosa*. A second sample was taken from this location in 1957, when the temperature was 10° higher. The slime was much more abundant and most of it was due to fungal mycelium. The fungal flora was very different from the previous sample and consisted of the following organisms: *Pachybasium niveum*, *Phialophora fastigiata*, *Phialophora* sp., *Pyrenochaeta* sp., and *Trichoderma lignorum*.

Location 3. A slime was accumulating on the sulfite flat screens in the same mill as the two previous locations. In 1956, at a temperature of 7°C. it contained the following fungi: *Cephalosporium* sp. and *Phialophora fastigiata*.

In 1957, the temperature was 14.5°C. and the following fungi were isolated from the slime: *Geotrichum*

D. BREWER, Atlantic Regional Laboratory, National Research Council of Canada, Halifax, N. S.

candidum, *Phialophora fastigiata*, and *Phialophora richardsiae*.

In November, 1958, the fungicide was different from that in use at the time of sampling in 1957, the temperature was 1°C. and the following fungi were isolated: *Geotrichum* sp. and *Phialophora fastigiata*. In all these samplings, the predominant fungus arising on the dilution plates was *Phialophora fastigiata*.

Location 4. The slime accumulating at the accepted stock line of the secondary Centri-Cleaner in the sulfite system of another mill in New Brunswick was first sampled in March, 1956, when the temperature of the system at this location was 7 to 8°C. The following fungi were isolated from the sample: *Geotrichum candidum*, *Phialophora fastigiata*, *Phialophora lignicola*, *Phoma* sp., and *Sporotrichum* sp.

In November, 1957, the temperature at which the slime was accumulating at this point was 9°C. and the following fungi were isolated: *Geotrichum candidum*, *Phialophora fastigiata*, *Phialophora* spp., and *Phoma* sp.

In April, 1958, with the temperature at 8°C. the sample of slime yielded: *Geotrichum candidum*, *Phialophora fastigiata*, and *Phoma* sp. The dilution plates from this sample produced colonies of *Phoma* sp. almost to the point of exclusion of any other fungus.

In September, 1958, after the regular fungicide had been used for a few days following a few weeks trial with another fungicide, slime was accumulating at the location at a temperature of 25°C. Dilution plates from a sample taken at this time yielded colonies of the following fungi: *Geotrichum candidum*, *Geotrichum* sp., *Phialophora fastigiata*, and *Phoma* sp.

Location 5. This location of slime accumulation was at the sulfite stock screens in the same mill as Location 4. All the samples were collected at the same time as the samples from Location 4. The slime was first sampled in March, 1956, when the temperature was 7 to 8°C. This sample yielded: *Geotrichum* sp., *Phialophora fastigiata*, and *Sporotrichum* sp.

At the time of the second sampling, in November, 1957, the temperature was 4°C. and the fungal flora was slightly different: *Cephalosporium* sp., *Endomycopsis* sp., *Phialophora fastigiata*, *Phoma* sp., and *Sporotrichum* sp.

In April, 1958, the slime sample taken from this location, where the temperature was now 8°C. contained the following fungi: *Cephalosporium* sp., *Geotrichum candidum*, *Hormiscium* sp., *Phialophora* spp., *Phoma* sp., and *Sporotrichum* sp.

The slime accumulating at this point was again sampled in September, 1958, and the following fungi were isolated: *Geotrichum candidum* and *Sporotrichum* sp.

DISCUSSION

Though many of the marked differences in the fungal floras of slime accumulations can be correlated with a difference in temperature or fungicide, other factors may induce changes in the fungal flora. It has been shown that growth stimulants may be present in "white" water (*2*) which probably originate from the wood. If this is the case, and if different species of wood contain different growth stimulants, then it is possible that the percentages of the various woods used could affect markedly the species of fungi present in a slime accumulation at a specific time. This could affect not only the composition of the slime, but also the amount.

The samplings at Locations 4 and 5 in April, 1958 furnished some interesting results. The two locations were in the same system and the temperatures were identical at the time of sampling. Yet examination of the samples showed quite a marked difference in their fungal floras. The most conspicuous differences were that *Phialophora fastigiata* was present in the slime from Location 4 and absent in Location 5, while the reverse was true for *Sporotrichum* sp. These two species are extremely common in slimes accumulating at relatively low temperatures in sulfite systems. Because the two locations were in the same system, one would expect that the available nutrients would be very similar and the growth stimulants present, if any, would be the same. Yet with similar temperatures, the floras were different. Could the physical environment, such as aeration, rate of flow of stock, and surface on which the slime is accumulating, have had a sufficient effect on growth as to account for the differences in floras? Stern (*5*) has suggested that the physical environment has a marked effect on the composition and amount of slime. However, both the species of fungi under consideration have grown in the two locations under similar conditions and the two species are present in the system. The possibility of the presence of different strains of a species in a mill system must not be overlooked. It has been shown that strains of *Phialophora fastigiata* do exist which differ in their abilities to utilize various nutrients (*3*). Strains which differ in their rates of growth under different physical stimuli are also possible. The fact that a species is present in the accumulation at one location does not necessarily imply that it will be present at another location, even though this species has been reported previously, under similar conditions, at the second location. Thus the strain capable of rapid and competitive growth at one location may not be capable of such growth at another location.

The slime accumulations under consideration in this report were predominantly fungal in nature. However, bacteria were present in all samples, in varying proportions. Indications of the enhancement of growth of some of the fungi by bacteria have been obtained (*4*). If the increase in growth rate of a fungus is dependent upon the presence of species of bacteria, then this could conceivably have a marked effect on the composition of the fungal flora and the amount of slime formed. The association of bacteria with fungi in slime is worthy of more extended observation and experiment.

The work in this paper bears out the contention of Stern (*5*) that any specific measure of control is necessarily temporary due to the alterations in the physicochemical environment. It also emphasizes the paucity of information on the effect of the mill environment on the composition and amount of slime, and on the basic effects of associations of microorganisms, both fungi and bacteria. As Zabel has pointed out (*6*), such information is essential for a sound program of control.

LITERATURE CITED

1. Brewer, D., *Can. J. Botany* 36: 941–946 (1958).
2. Brewer, D., *Can. J. Botany* 37: 517–521 (1959).

3. Brewer, D., *Can. J. Botany* 37: 339–343 (1959).
4. Brewer, D., Unpublished results.
5. Stern, A. M., *Tappi* 42, No. 7: 605–609 (1959).
6. Zabel, R. A., *Tappi* 42, No. 5: 28A-34A (1959).

Received Jan. 11, 1960.

The author wishes to thank Mrs. Jean Fraser and Mrs. Kathleen Manderville for their technical assistance and Dr. E. G. Young for his aid in the preparation of the manuscript. He gratefully acknowledges the assistance of the mills cooperating in this study.

Contribution from the Atlantic Regional Laboratory, National Research Council of Canada, Halifax, N. S. Issued as NRC 5678.

Studies on the Chemistry of Aspenwood

VI. Products of Alkaline Hydrolysis of Various Portions of the Aspen Tree

IRWIN A. PEARL and DONALD L. BEYER

The sapwood, heartwood, rootwood, and bark of a quaking aspen tree were subjected to alkaline hydrolysis at atmospheric pressure, and the products liberated were determined qualitatively and quantitatively. Data indicate that the yields of known compounds from sapwood and heartwood are essentially the same except for syringaldehyde which appears to be concentrated in the sapwood. The bark yields more of all materials except *p*-hydroxybenzoic acid, and its chief product of hydrolysis is *p*-coumaric acid. In contrast to the other portions of quaking aspenwood, the rootwood yielded ferulic acid and *p*-hydroxybenzaldehyde as the chief products of alkaline hydrolysis, and *p*-hydroxybenzoic acid was just a minor component of the hydrolyzate. Studies on the effect of particle size of the wood on the yields of products of alkaline hydrolysis indicated only little effect.

In continuing our studies on the occurrence of *p*-hydroxybenzoic acid and other phenolic compounds in the alkaline hydrolyzates of aspenwood and aspen-derived spent pulping liquors (*1*, *2*) it was desired to study the effect of location in the tree (with respect to cross section) on the compound-yielding ability of quaking aspenwood. Because other work in our laboratories (*3*, *4*) on the constituents of the phloem and soft xylem of this wood indicated a change in composition of the materials deposited on either side of the cambium, the bark and the rootwood of *P. tremuloides* were included in this study of the location in the tree on the compound-yielding ability of aspen.

STARTING MATERIAL

A large bolt of *P. tremuloides* was obtained on Oct. 17, 1956, from the center of a tree located at Bruce Crossing in Upper Michigan. The tree was 43 years of age, 77 ft. tall, 38 ft. to the first live branch, and the diameter at breast height was 10.2 in.

One section of the bolt was cut into sawdust. Another section was separated into heartwood and sapwood by the following arbitrary method: One end of the bolt was painted with a soap solution, and air was passed through the bolt. The outer portion of the bolt which passed air was arbitrarily taken as sapwood because of the absence of tyloses inhibiting air passage. The inner portion of the bolt which did not allow passage of air was arbitrarily taken as heartwood. Actually, the bolt was cut on a bandsaw to give a sapwood sample at least 1 in. within the boundary marked for heartwood and sapwood. Similarly, the heartwood sample was cut at least 1 in. within the boundary for the heartwood. The intermediate piece of wood containing the one or more inches on each side of the boundary was discarded. The portions of heartwood and sapwood were each ground into sawdust.

The bark and the roots were allowed to airdry and then ground to small particle size in a Wiley mill.

EXPERIMENTAL PROCEDURE

The whole sawdust, the sapwood, the heartwood, a 1:1 mixture of sapwood and heartwood, the bark, and the rootwood were each hydrolyzed with sodium hydroxide. The same procedure was employed on all samples. A mixture of the wood containing 100 g. of ovendry wood, 120 g. of c.p. sodium hydroxide, and 3000 ml. of water was stirred and boiled under reflux for 8 hr. The hot mixture was filtered, and the pulp washed thoroughly with warm water. The combined filtrate and washings were cooled and acidified with dilute sulfuric acid. The acidified mixture was extracted exhaustively with ether, and the ether was dried and concentrated. The concentrated ether solutions were analyzed qualitatively by paper chromatography and quantitatively by paper chromatographic and spectrophotometric methods previously described in detail (*5*, *6*).

Qualitative paper chromatography indicated essentially the same materials in all ether extracts. In addition to all the compounds present in the alkaline hydrolyzates of the wood and bark, the rootwood hydrolyzate contained a substantial amount of ferulic acid. Quantitative data are presented in Table I.

Table I. Known Compound Data for Various Portions of the Aspen Tree After Alkaline Hydrolysis

	Whole wood	*Sapwood*	*Heartwood*	*Sapwood-heartwood 1:1*	*Bark*	*Rootwood*
Ether extract, %[a]	2.28	1.96	2.02	1.81	9.23	3.04
Vanillin, %[b]	1.0	1.2	1.1	1.3	0.3	1.1
Syringaldehyde, %	1.4	3.0	1.2	1.8	3.1	1.6
p-Hydroxybenzaldehyde, %	1.3	0.5	1.2	0.9	0.9	4.1
Vanillic acid, %	1.7	1.9	2.4	1.9	2.8	1.4
Syringic acid, %	1.5	2.1	2.1	2.3	1.3	1.5
p-Hydroxybenzoic acid, %	21.6	25.2	24.8	27.1	1.2	1.1
p-Coumaric acid, %	4.0	2.6	3.2	2.8	7.4	0.3
Ferulic acid, %	0.0	0.0	0.0	0.0	0.0	3.4

[a] The per cent ether extract is on the basis of the solids in each experiment.
[b] The per cent of vanillin and all other compounds is on the basis of the ether extract of the particular experiment.

Irwin A. Pearl, Senior Research Associate and Chief, and Donald L. Beyer, Research Aide, Lignin Chemistry Group, The Institute of Paper Chemistry, Appleton, Wis.

Table II. Alkaline Hydrolysis of Aspen Sawdust and Finely Powdered Wood

	Sawdust	*100-Mesh wood*
Ether extract, %[a]	2.28	2.97
Vanillin, %	1.0	0.9
Syringaldehyde, %	1.4	1.5
p-Hydroxybenzaldehyde, %	1.3	2.6
Vanillic acid, %	1.7	1.9
Syringic acid, %	1.5	1.6
p-Hydroxybenzoic acid, %	21.6	17.0
p-Coumaric acid, %	4.0	7.9

[a] The per cent ether extract is on the basis of the solids in each experiment, and the per cent of the individual compounds is on the basis of the ether extract of the particular experiment.

DISCUSSION OF RESULTS

The data of Table I indicate several interesting facts. As noted earlier for *P. tremuloides* (*5*), the chief product of alkaline hydrolysis of the wood is *p*-hydroxybenzoic acid. Except for syringaldehyde, the yields of other individual compounds are essentially the same for both sapwood and heartwood. Syringaldehyde-yielding moieties appear to be concentrated in the sapwood. The yield of *p*-hydroxybenzoic acid appears to be lower in the whole wood than in either the sapwood or heartwood, but it should be noticed that the yield of ether extract was higher in the case of the whole wood. On the basis of the original wood employed, all yields were substantially identical.

P. tremuloides bark appears to be a good source of *p*-coumaric acid. The yield of total extract of the bark is much higher than on any wood fraction, and the yield of *p*-coumaric acid is relatively high on the basis of the ether extract. Whereas *p*-hydroxybenzoic acid is the chief component of aspenwood hydrolyzate extracts, *p*-coumaric acid is the chief component of aspen bark hydrolyzate extract. Obviously, *p*-hydroxybenzoic acid is not the "common denominator" of aspen bark as it is in aspenwood (*7*).

Although the yield of ether extract obtained from the alkaline hydrolysis of the rootwood is approximately the same as that obtained from the alkaline hydrolysis of the whole wood, the combined yield of known compounds is approximately one half of that obtained with the whole wood. In addition, one of the chief components of the rootwood alkaline hydrolyzate is ferulic acid, a compound not even found in the alkaline hydrolyzate of *Populus tremuloides* wood. The significance of finding ferulic acid in the rootwood hydrolyzate and not in the wood hydrolyzate is not known at this time. The exceptionally low yield of *p*-hydroxybenzoic acid, relatively low yield of *p*-coumaric acid, and relatively high yield of *p*-hydroxybenzaldehyde in the rootwood hydrolyzate are noteworthy, but cannot be explained.

EFFECT OF PARTICLE SIZE ON THE YIELDS OF KNOWN COMPOUNDS

It was desired to determine whether availability of certain portions of the aspenwood to the boiling alkaline solution was a factor in the yields of the various compounds obtained on alkaline hydrolysis of aspen. This was especially important in the case of *p*-hydroxybenzoic acid, a compound which is not formed through oxidation of moieties of lower oxidation level in the wood, but probably by hydrolysis of esters or the like through the action of alkali or acid (*7*, *8*).

Table III. Alkaline Hydrolysis of Aspen Sawdust an Finely Powdered Wood

	Sawdust	*100-Mesh wood*
Ether extract, %[a]	2.36	2.43
Vanillin, %	1.2	1.2
Syringaldehyde, %	1.4	1.8
p-Hydroxybenzaldehyde, %	2.3	3.1
Vanillic acid, %	2.5	2.5
Syringic acid, %	2.0	2.1
p-Hydroxybenzoic acid, %	18.3	18.0
p-Coumaric acid, %	2.0	3.9

[a] The per cent ether extract is on the basis of the solids in each experimen and the per cent of the individual compounds is on the basis of the ether e tract of the particular experiment.

A sample of the whole aspen sawdust employed abov was passed through the Wiley mill several times, an finally passed through a 100-mesh sieve. Care wa taken to insure that all original wood was screened The screened powdered wood was processed exactl as described above for the sawdusts. A compariso of yields obtained from the sawdust and powdered woo is given in Table II.

The data of Table II indicate that the finely divide wood gave essentially the same yields of individua compounds on the basis of the ether extract except i the cases of *p*-hydroxybenzaldehyde and *p*-coumari acid. The yield of ether extract in the experiment wit powdered wood was somewhat higher, so the overa yields of most compounds was a little higher than in th sawdust experiment. However, in the case of *p* hydroxybenzoic acid, the overall yield was identica with that obtained in the sawdust experiment, indicat ing that this value is probably a limiting value for thi compound in this particular wood sample.

In the cases of *p*-hydroxybenzaldehyde and *p*-cou maric acid, the finely powdered wood yielded twice a much product as did the sawdust, indicating muc better availability to the alkaline solution of moieti yielding these two compounds on alkaline hydrolysis.

In order to determine whether the results obtained i these experiments were applicable generally anothe bolt of authentic *P. tremuloides* was obtained. Thi bolt was from a tree cut at Bruce Crossing in Uppe Michigan a few months after the first tree. This tre was 52 years of age, 72 ft. tall, and 10.5 in. in diamete at breast height. The bolt was cut into sawdust, an some of the mixed sawdust was powdered in the Wile mill and screened to pass a 100-mesh sieve. Again care was taken to insure that all of the sample taken fo powdering was screened. Samples of the original saw dust and of the 100-mesh wood were hydrolyzed a described above, and the ether extracts obtained wer analyzed. Data are given in Table III.

The data of Table III indicated that, in this ex periment, although some of the individual yields ar somewhat different than those from the other tree i the last experiment, the sawdust and the finel powdered wood gave essentially the same yields o compounds except for *p*-hydroxybenzaldehyde and *p* coumaric acid. Again, the overall yields of *p*-hy droxybenzoic acid in both wood samples were identical.

LITERATURE CITED

1. Pearl, I. A. and Beyer, D. L., *Tappi* 40: 45 (1957).
2. Pearl, I. A. and Beyer, D. L., *Tappi* 42: 800 (1959).
3. Mugg, J. B., *Tappi* 42: 289 (1959).
4. Faber, H. B., submitted to *Tappi*.
5. Pearl, I. A., Beyer, D. L., Johnson, B., and Wilkinson, S. *Tappi* 40: 374 (1957).

6. Pearl, I. A., Beyer, D. L., and Johnson, B., *Tappi* 41: 255 (1958).
7. Pearl, I. A., *Tappi* 41: 621 (1958).
8. Smith, D. C. C., *J. Chem. Soc.* 1955: 2347.

Received Dec. 23, 1959.

This paper represents a portion of the results obtained in the research program sponsored by the Sulfite Pulp Manufacturers' Research League and conducted for the League by The Institute of Paper Chemistry. Acknowledgement is made by the Institute for permission on the part of the League to publish these results.

A Continuous Freeness Recorder for Pulp Suspensions

D. J. WILLIAMS

An instrument for recording freeness continuously is described in which the recorded values are automaticlly corrected for variations in temperature and stock concentration. The stock to be tested is diluted at the unit to approximately 0.8%. It then passes along a delivery channel where variations in concentration are sensed electronically by the rise and fall of a float actuated core in a differential transformer. Samples of the diluted stock are fed into a 1-liter capacity vessel with a bottom consisting of a perforated freeness plate. The base of the pot is sealed for a short time before the stock is allowed to drain freely for a predetermined period. The pot is then emptied, washed, and recharged for the next test. Drainage water is collected in a measuring tank where d.c. voltages proportional to its volume and temperature are derived electronically. This volume is a measure of freeness and it is influenced by variations in stock concentration and temperature. The measuring systems for stock concentration and temperature derive d.c. voltages of amplitude and polarity which are dependent upon the degree and direction of changes from nominated standards in either value. These voltages are maintained automatically in the appropriate proportion to the freeness value and are combined with the voltage derived from the drainage rate volume. The mean of the tests is presented as a continuous recording. The effect of freeness variation on formation is illustrated.

The behavior of a pulp suspension on the paper machine wet end and the strength of the sheet made from it is largely governed by the degree of beating the pulp has received.

This is usually measured by freeness or the rate at which water will drain through a mat of pulp formed under predetermined conditions of stock concentration and temperature. The literature refers to three types of instruments (*1–3*) which have been developed for the continuous recording of this property but none of these appears to have been accepted by the industry and the general practice is for the results of periodic manual tests to be graphed for the guidance of operating personnel. Frequently, the period between tests is too long for significant short term changes to be detected and for taking any immediate remedial measures which may be necessary.

The development of various types of freeness testers up to the stage where the Canadian Freeness tester was generally accepted by the industry has been fully dealt with by Clark (*4*). The Canadian unit embodies the principle of divided flow originally developed by Schopper and Reigel (*4*) who in working on the Klemm sedimentation tester (*4*) observed that all pulps showed a very rapid discharge at the beginning of the test followed by a more or less rapid decrease in the rate of flow. It was also noted that a lightly beaten pulp would discharge over half its total volume in this sudden rush while very heavily beaten pulps would discharge less than 10% of the total volume in this manner.

By using a cone with two discharge orifices one of small bore at the bottom and the other of larger bore in the form of a sidearm, the sudden rush of water from lightly beaten pulps was mainly discharged through the larger orifice while with the heavily beaten pulps almost all the water was discharged through the lower orifice. By utilizing this division of the total flow and by measuring the volume of water discharged from the larger orifice a clean end point is obtained and the range of difference between lightly and heavily beaten pulps is considerably extended.

An improved unit using this principle was developed by Green (*4*) and the Canadian Forest Products Laboratory adopted a more rugged version of the Green unit in 1919. This is the currently used Canadian Standard freeness tester.

It was proposed to simulate this instrument in an automatic batch testing unit but with two main differences: (a) operation would be at a higher stock concentration to facilitate the measurement of stock concentration variation and subsequent automatic cor-

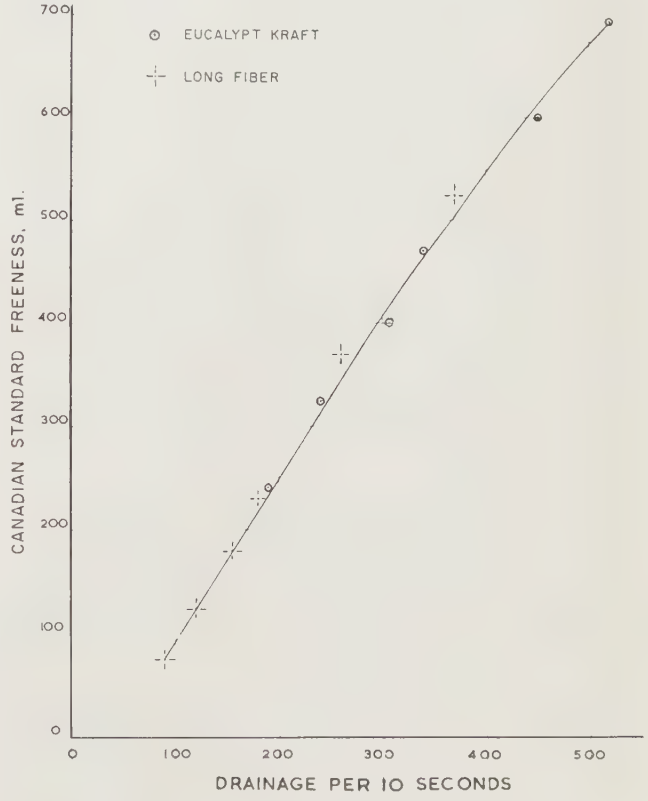


Fig. 1. Total drainage per 10 seconds vs. freeness

D. J. Williams, Senior Research Instrument Engineer, Australian Paper Manufacturers, Ltd., Melbourne, Australia.

rection, (b) it was desirable to eliminate the smaller orifice to avoid the hazard of blockages. It was assumed that a measurement of total drainage over a finite period at a higher stock concentration would correlate with Canadian Standard freeness.

To test this assumption drainage tests were done on stock at 0.8% stock concentration by measuring the total volume drained over a period of 10 sec. and comparing the results with the C.S. freeness values for the same pulp samples. The correlation (Fig. 1) was sufficiently good to warrant the use of this principle.

DEVELOPMENT OF BATCH TESTING FREENESS RECORDER

Detailed Description

Pulp Dilution and Delivery System. The developmental unit operated on blended eucalypt and long fiber stock at freenesses up to 580 C.S. Tested stock was returned to the system.

The general arrangement of the entire unit is shown in Fig. 2.

Pulp from the headbox is fed via a 4-in. flexible hose to a tank *A* where it passes over a weir and back to the machine chest. From tank *A* the stock is fed under the constant head formed by the weir through a 3-in. diam. pipe to a second tank B where it is diluted to approximately 0.8% concentration with water supplied through a 5- to 30-p.s.i. reducing valve set to regulate at a pressure of 15 p.s.i. The dilution water passes through a fishtail jet and is applied across the outlet from tank *A* to ensure good mixing.

A weir in tank *B* provides a constant head under which the diluted pulp discharges through a $^3/_4$-in. orifice to the delivery channel. Overflow from this weir also passes into the common overflow to the machine chest. Stock concentration variations are sensed by electronically detecting the rise and fall of a counterbalanced float on the pulp as it passes along the delivery channel. A triple-plate baffle is situated in front of the $^3/_4$-in. orifice to eliminate flow pulsations along the channel.

The stock passes from the delivery channel into the small vessel *D* which is situated in tank *C*. *D* provides a reservoir of approximately 600 ml. of stock which together with the quantity of stock flowing into the pot while the rotary valve *E* is open, gives a test quantity of stock just in excess of the capacity of the freeness pot. The discharge from *D* is via a 2-in. o.d. outlet in which is fitted a length of $^3/_4$-in. i.d. tubing, the height of which is adjustable. The positioning of this tube provides a fine adjustment of the total discharge of stock into the freeness pot so that excessive overflow may be avoided.

The 2-in. outlet is sealed against the rotary valve by a gasket of isocyanate foamed plastic.

The stock falling into *D* from the delivery channel agitates the stock awaiting discharge to the pot. Overflow from *D* passes into the common return system to the machine chest.

Freeness Testing Section. The freeness testing section consists essentially of a vertical shaft which drives two freeness pots over a track that forms a seal while they are being filled and then allows free drainage for a finite period. After drainage the pots leave the

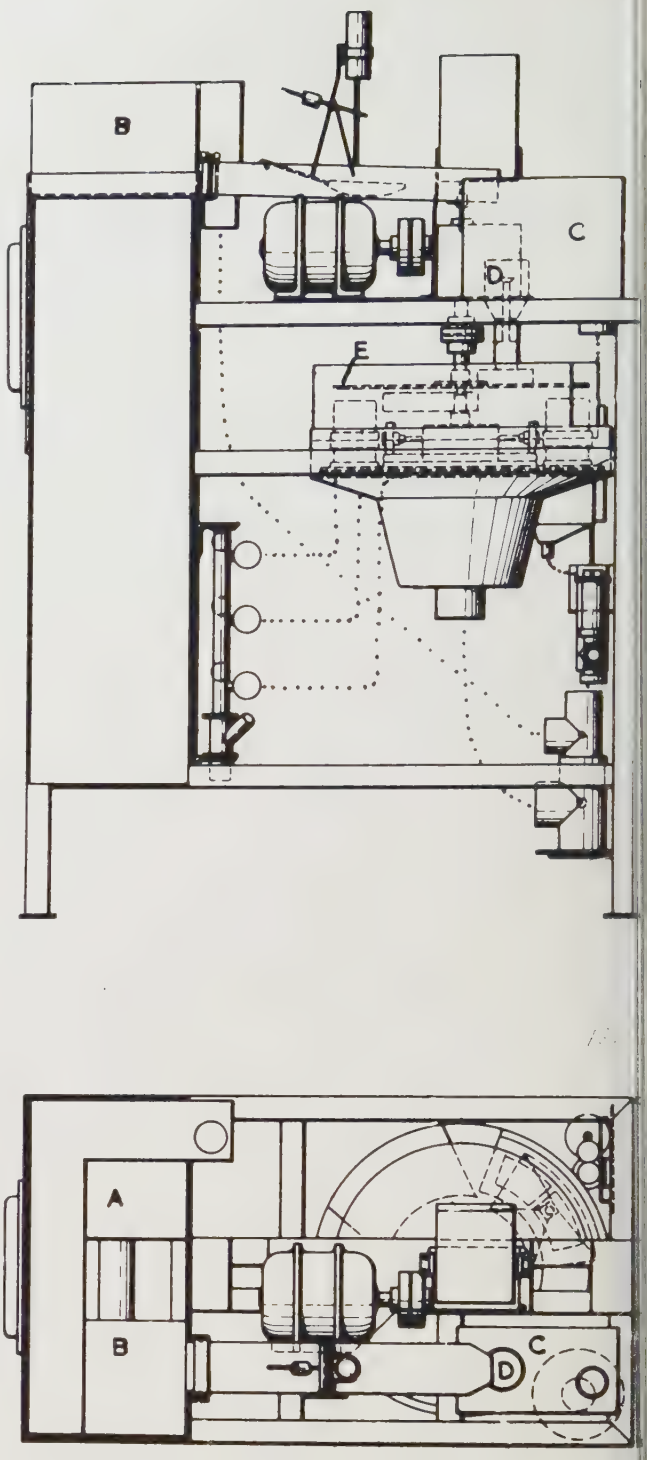


Fig. 2. General arrangement

track, are inverted for cleaning and then re-engage the track to be refilled.

At the bottom of the vertical shaft which is driven at 1 r.p.m. there is fixed a 3-in. diam. block into which two $^1/_2$-in. bushings are sweated to provide diametrically opposite bearings for two independent horizontal $^1/_2$-in. diam. freeness pot supporting shafts. Each of these shafts has a $^1/_4$-in. wide recess $^7/_{16}$ in. from the end by which the lateral position is fixed with $^3/_{16}$-in. set screws adjusted from the top of the block so that they protrude through the bearing to locate the shaft. Each shaft also has a $4^1/_8$-in. i.d. ring of $^1/_2 \times {}^5/_{16}$-in. section fixed to the end to give a clearance of $^1/_{16}$-in. around the freeness pot which it drives.

Each freeness pot is made from 4-in. diam., 1/8-in. bronze tubing and is of 1 liter capacity. The bottom of each pot is threaded and a retaining ring is screwed on to hold a Canadian Standard freeness drainage plate in position. This ring is made of L.A.3 Ferrobestos which was found to have the best wearing characteristic of several materials tried, including nylon, Teflon, Laminite, and brass.

Two other rings are fitted to each pot, one above and one below the ring attached to the horizontal drive shaft so that the vertical position of the pot is maintained about the driving ring while the pot is passing through the washing stage where it is unsupported by the base track which is described later. These rings are of sufficiently large internal diameter to slide over the pots to which they are held by grub screws.

The top ring has a skirt 1/64-in. greater diameter than the outside diameter of the driving ring over which the skirt forms a canopy to prevent pulp from accumulating between the rings; the necessary freedom of movement of the pot within the driving ring is thereby maintained. As the driving ring engages the skirt the pot is pulled rather than pushed and this is an important factor in reducing judder. A section is cut from the top back edge of each pot to divert overflow to the rear.

The pinion of a gear wheel and pinion combination is mounted on the pot-supporting shaft near the bronze bearing block and as the main vertical shaft is rotated the stage is reached where this gear is caused to engage a sector cut from its complementary gear wheel which is fixed to the base support for the freeness pot assembly. In this way the pots are rotated through 360° for discharge of the tested samples and for cleaning.

The main base is a bronze ring of 12 1/2 in. i.d. and 7/8 × 3/4-in. section. Fitted diametrically beneath this ring is a 2 × 3/16-in. strap in the center of which the fixed gear sector is mounted.

The pot assembly is mounted on the center section of the fixed gear sector with the two assemblies being separated by a thrust bearing. The end of the main vertical drive shaft which extends below the pot shaft bearing block passes through the center of the fixed gear and the spacing block to center the pot assembly on the base ring. The top of this shaft is coupled to the output shaft of the reduction gear box through a flexible coupling.

The rotary valve which is mounted just above the pots on the vertical drive shaft is a 23-in. diam. disk of 1/8-in. stainless steel with two 1 1/2-in. diam. holes located so that each is immediately above a freeness pot.

The ground and polished stainless steel track over which the pots are driven for 240° of each cycle is bolted to the bottom of the main base ring through 1/2-in. spacers which provide a space for spray water and excess pulp to pass through to the drainage system beneath the pots. This track forms a seal with the retaining ring on the bottom of each pot for 180° of the cycle. Following this section the track is cut away for approximately 40° so that the pulp may drain freely while the pot is over this section, the period being approximately 10 sec.

The stationary gear is placed so that when the pot leaves this drainage section it is engaged by the pinion on the pot shaft which is then caused to rotate vertically through 360° to discharge the tested sample, and pass over washing sprays. The pot then slides onto the base track where the gears are disengaged.

To reduce the load on the pot shaft bearings when the gears are engaged and the pot is unsupported by the track, Laminite wheels are mounted on each pot shaft and held in place by collars so that they ride on the base ring. Small rubber bladed sweepers also mounted on the pot shaft ride on the base ring ahead of the wheels to deflect any accumulated pulp into the drainage system.

The entire freeness pot testing assembly is leveled and fixed in three positions to the side of a 27-in. diam. stepped cone which is of 16-g stainless steel. The receptacle for the drainage water is fitted into the step of the cone and its outlet is connected to a measuring tank containing a float on which is mounted a steel rod. A pocket to house the thermistor for the measurement of drainage water temperature is fitted at the bottom of the tank below the discharge coupling to the solenoid valve. The tested stock, spillage, and spray water pass into the center of the cone and into the drain via the 4-in. diam. outlet at the center of the lower section. Removable baffle plates are fitted to the outside of the casing. A hood is fitted at the point where the freeness pots are washed to prevent spray water from being deflected into the drainage water receptacle.

The freeness pot revolving gears are protected from spray water by a cylindrical cover mounted on the main vertical drive shaft.

Four cleaning sprays are situated at intervals around the main casing. One is mounted so that it directs a stream onto the bottom of the freeness plate when the pot commences to invert. The second is placed at 70° to the horizontal and in the direction of travel to spray into the pot when it is inverted. The third sprays the track at the point where the pot first meets it. The fourth is placed just after the filling point and directs its jet along the track against the direction of rotation to disperse any overflow from the pot.

A small drain is fitted below the track at the beginning of the drainage test section to divert any spray water which would otherwise be swept into the re-receiving tank by the advancing pot. The vertical shaft of the reduction gear box is extended via a flexible coupling above the box for the activation of microswitches which control the sequence of operations.

Timing of the Instrument. The timing is set so that during each 60-sec. interval of rotation of the main drive shaft both pots are filled, the cumulative drainage rate is registered, and the pots are rotated through 360° in the vertical plane for washing.

Taking the beginning of the drainage period of one pot as the commencement of the cycle, a solenoid valve which empties the measuring tank is set to close just as the leading edge of the pot reaches the drainage test section. It remains closed until the 51st sec. while the drainage water from both pots accumulates in the measuring tank and raises the float to a position which is registered by the transient peak voltmeter. It then opens until the 60th sec. to allow the drainage water to flow from the measuring take.

To meet this requirement the solenoid valve switch is operated by a cam segment of 54° set to start at 306° in the 360° cycle.

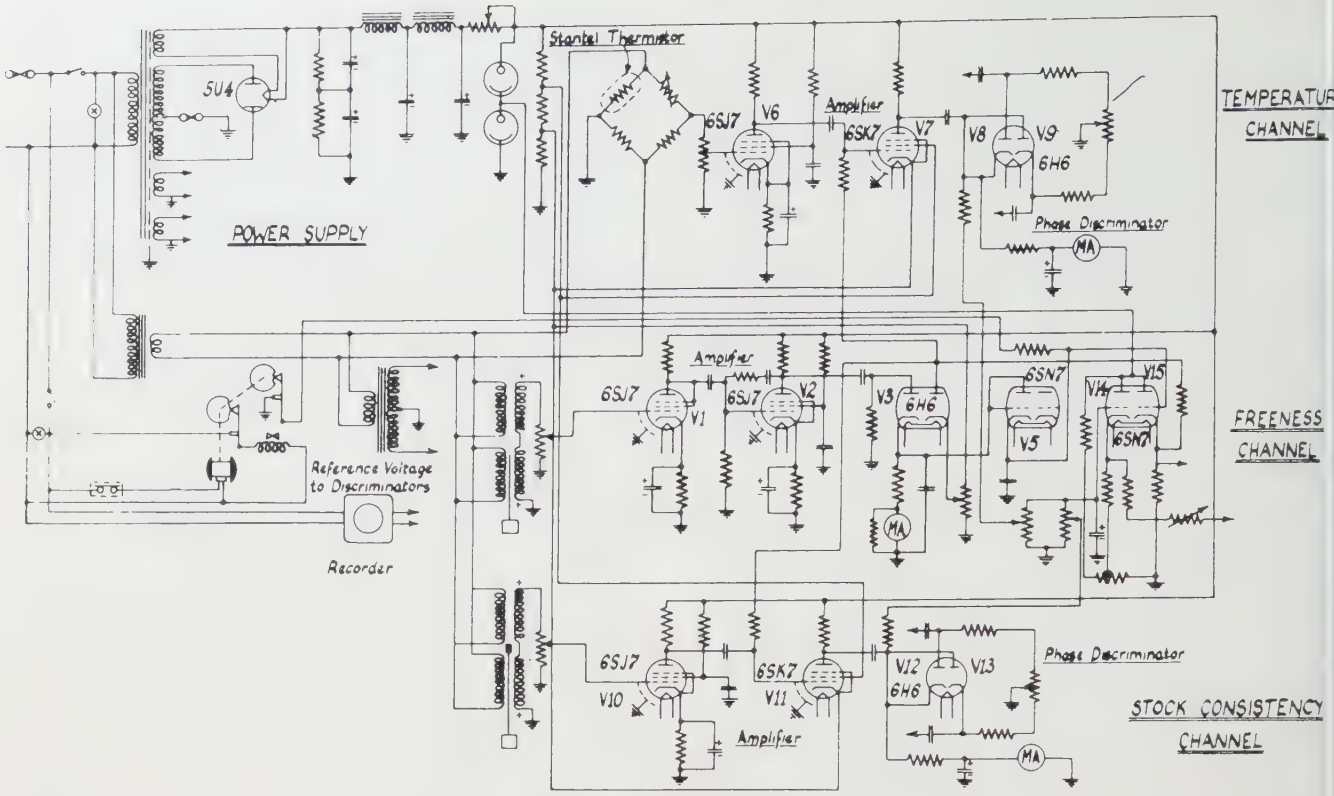


Fig. 3. Circuit diagram

The transient-peak voltmeter supplies to the recorder movement a voltage proportional to the mean peak value of the tests. The response to any increase in freeness is immediate but downward response is normally limited by the rate of discharge of the storage capacitor. This is compensated for by a second cam operated switch arranged to connect a bleed resistor across the storage capacitor when every peak value is reached during the 49th and 50th sec. of the cycle, so that in the event of a reduced freeness the capacitor is allowed to discharge rapidly to the new value.

This cam has one 12° segment which is placed to operate over the 294° to 306° sector of the cycle. All switches have paralleled contacts for greater reliability.

Description of Circuit

Freeness Measurement. The differential transformer which is situated above the drainage water measuring tank consists of two identical sections placed side by side. One section receives the galvanized steel rod attached to the measuring tank float and the other accommodates any balancing slugs that may be necessary.

The output voltage from this transformer resulting from the introduction of the steel rod is applied to the freeness amplifier. This amplifier comprises a triode connected 6SJ7 (V_1) feeding a second 6SJ7 (V_2) which in turn feeds the metering diode $^1/_2$ 6H6 (V_3) the rectified current of which is measured by a 50-microamp. meter in the cathode circuit. The d.c. voltage at the cathode of V_3 is applied to the transient peak voltmeter diode V_5 ($^1/_2$6SN7) through which the 8-μf paper condenser is charged to the peak value of the voltage arising from the measurement of each test sample. The voltage on this condenser is applied to the control grid of one section of the differential metering amplifie stage V_{14} and V_{15} (6SN7). With zero input the cathod currents through V_{14} and V_{15} are balanced. In th condition both cathodes are at the same potentia above earth. When a voltage appears at the grid c V_{15} its cathode current increases and the potentia difference which then exists between the cathodes measured and recorded. The leakage resistance i the circuitry associated with the transient peak vol meter charging capacitor is such that a decay of ap proximately 2% of the voltage to which it is charge occurs during the period of 1 min. between tests. A this imposes a considerable limitation on the spee of the downward response of the voltmeter the pro gramming microswitch on the extended vertical driv shaft connects a shunt resistance of 10 megohms acros the capacitor when the peak value of each test reached. In this way the overall discharge rate not affected but the instrument is able to follow a dow ward trend almost as quickly as an upward trend.

Temperature Correction. Drainage water tempera ture is measured at the bottom of the measuring tan where a convenient reservoir is formed for this purpose peak value of the tests. The sensing unit is a Stante thermistor Type 2311/300 connected in a bridge circui and the unbalance that results from temperature varia tion is amplified by a two-stage amplifier of one 6SJ (V_6) feeding a 6SK7 (V_7). The output of V_7 feeds phase discriminating rectifier (V_8 and V_9) 6H6 fro which is derived either a positive or negative d.c. voltag of amplitude and polarity dependent on the magnitud and direction of the temperature variation.

This d.c. voltage is then applied in the appropriat proportion to the grid circuit of V_{14} as selected by ad justing the "temperature correction" potentiometer It then causes the cathode current of that section t

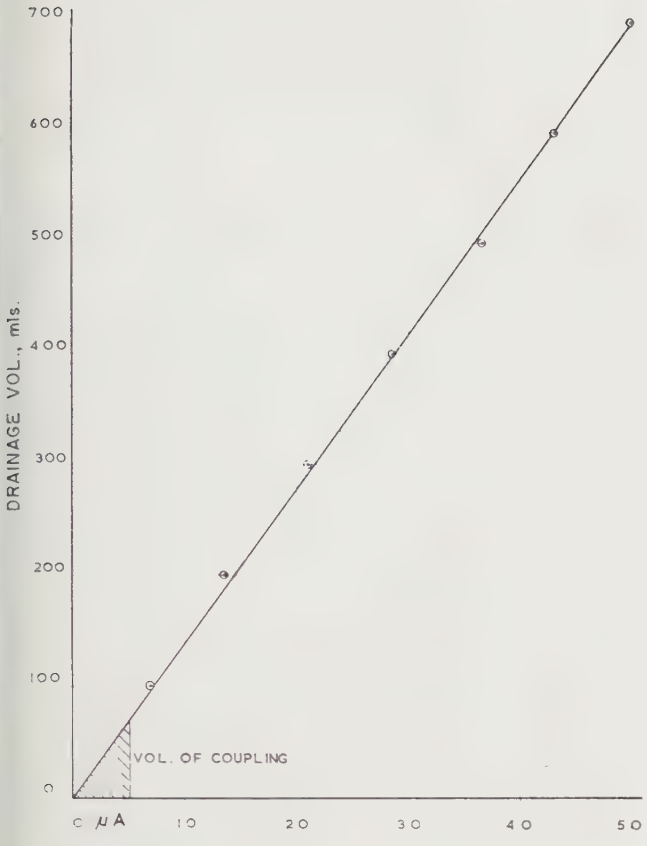


Fig. 4. Calibration of freeness channel

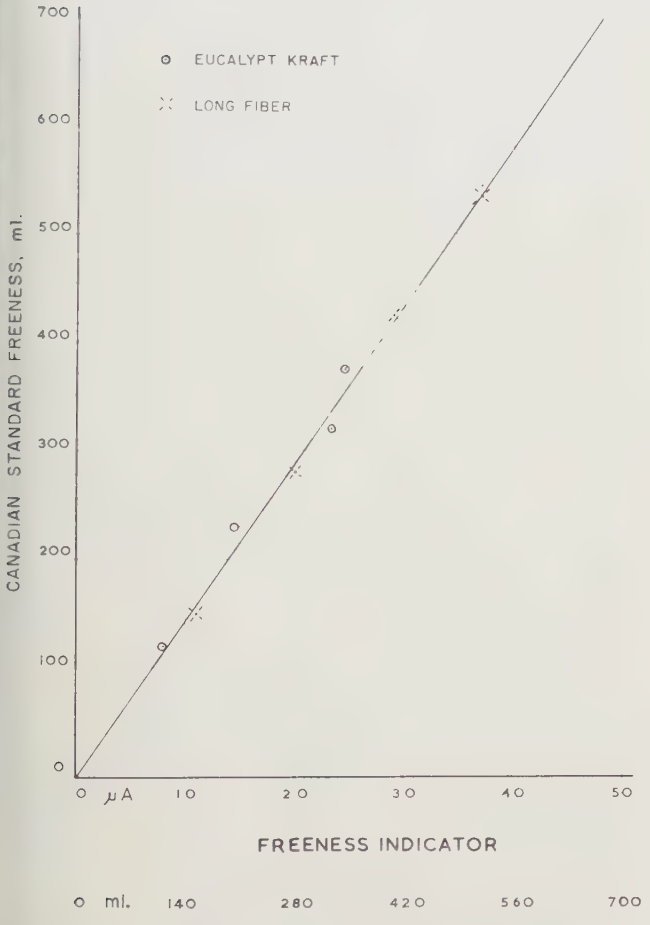


Fig. 5. C.S freeness vs. freeness channel output

Calibration may vary with different freeness plates. Compensation can be effected by adjusting "freeness gain."

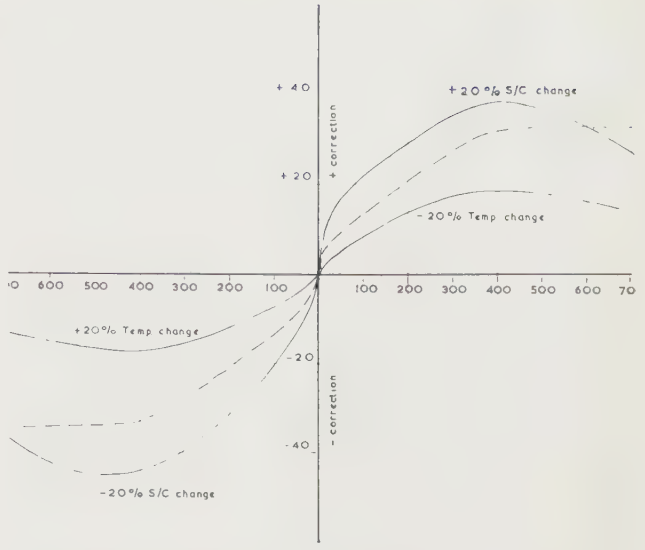


Fig. 6. Form of temperature and S/C correction

—— Form of C.S. freeness correction. — — — Form of instrument correction.

Slope and y intercept of instrument correction is automatically governed by freeness.

vary and so adds to or subtracts from the potential difference existing between the cathodes of V_{14} and V_{15} due to the freeness value.

Stock Concentration Correction. The stock concentration measuring section comprises a differential transformer which measures the rise and fall of a float in the pulp delivery channel.

The two units of this transformer are end on, and its height is adjusted so that a steel core which is supported on the float by a copper rod is midway between the two sections at the desired operating stock concentration.

As the float rises or falls with stock concentration variation an unbalance voltage appears and is applied to the stock concentration channel amplifier comprising V_{10} (6SJ7) and V_{11} (6SK7) similar to that used in the temperature channel with the output from V_{11} being applied to the phase discriminating rectifier V_{12} and

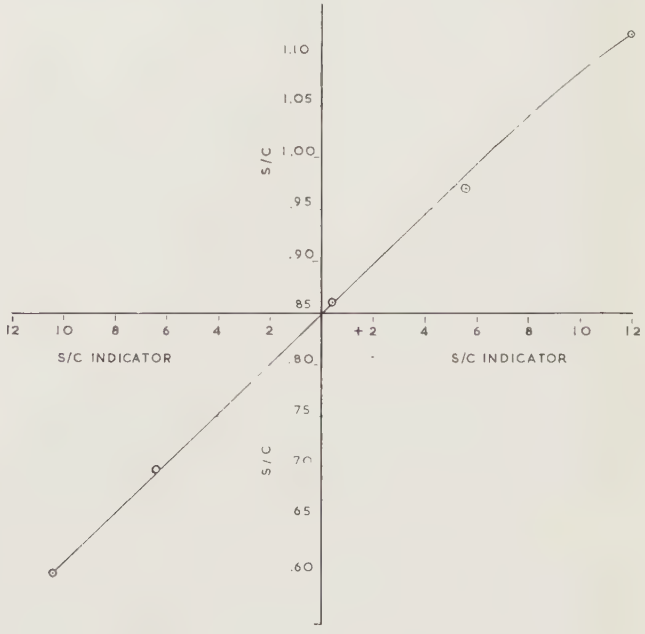


Fig. 7. S/C indicator vs. S/C

Slope is adjusted by "S/C gain" and controlled by freeness.

V_{13} (6H6) by which means a positive or negative d.c. voltage is similarly derived. This voltage is also applied in the appropriate proportion as selected by the "S/C correction" potentiometer to the grid circuit of V_{14}. It then similarly causes the cathode current of that section to vary and so adds to or subtracts from the potential difference existing between the cathodes of V_{14} and V_{15} due to the freeness value.

These correction controls are in parallel in the grid circuit of V_{14} and the corrections for temperature and stock concentration variation may oppose or assist as required by the circumstances.

The gain of the second stages of the stock concentration and temperature channels is automatically controlled by the output of the freeness channel as derived from the cathode of V_{15}. A higher freeness increases the gain of these channels and maintains any correction voltage in the appropriate proportion. As the correction characteristic for stock concentration which is by far the most frequent variable, flattens at a freeness corresponding to approximately 400 C.S. freeness, a diode (V_4) is connected from the A.G.C. line to earth and biased so that it bypasses any A.G.C. voltage above that corresponding to a freeness of 400.

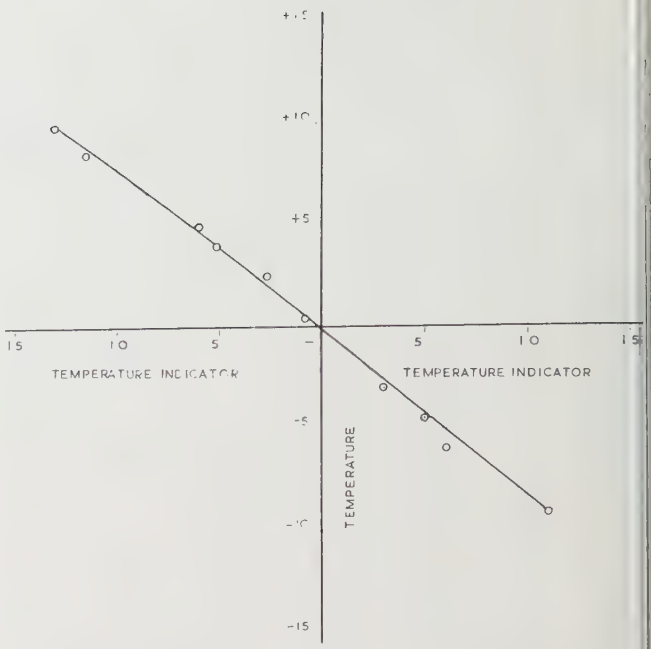


Fig. 8. Temperature indicator vs. temperature
Slope is adjusted by "temp. gain" and controlled by freeness.

Calibration of the Freeness Channel

The calibration of the freeness channel is substantially linear to a volume of 700 ml. (Fig. 4) which corresponds to a float rise of 15 cm. with a 3-in. diam. measuring tank. This volume is sufficient to cover the drainage volume obtained from a pulp of 700 C.S. freeness when tested in this instrument at 0.8% S/C.

The drainage volumes measured by the unit for pulps of 0.8% stock concentration at various freenesses are plotted on the freeness channel calibration graph (Fig. 5) and it will be seen that by taking 700 C.S. freeness as equivalent to the 700 ml. full-scale value of the freeness indicator, good correlation is obtained with the actual C.S. freeness values of the samples tested.

If it is desired to double the sensitivity and operate over either the upper or lower half of the freeness scale with full-scale deflection (f.s.d.), the "recorder sensitivity" control must be adjusted to give f.s.d. for 350 ml. The unit will then show a full-scale deflection equivalent to 350 C.S. freeness. For operation over the upper half of the range from 350 to 700 C.S. freeness it is then necessary to increase the height of the differential transformer over the measuring tank so that a reading of zero is obtained with 350 ml. of water in the measuring tank. In this case a guide may be required to direct the float rod into the former.

When an instrument is required to operate permanently over a reduced range it is advisable to use a measuring tank of a diameter which will give a float rise of 15 cm. for the volume corresponding to the maximum freeness of the range. It is necessary to offset the zero to compensate for the volume of the coupling between the measuring tank and the solenoid valve. In the experimental unit the actual range covered was from 70 to 700 C.S. freeness.

Compensation for Consistency and Temperature Variation

Although it is preferable to supply stock of constant concentration and temperature to the unit, provision has been made to compensate automatically for changes in stock concentration ranging from 0.65 to 1.1% and temperature changes of ±10°C. While these corrections are not ideal, errors, in freeness reading of up to 20%, which can result from extreme changes in these properties if uncorrected, are reduced to the order of 3%.

Correction for Stock Concentration

The compensation for stock concentration and temperature variation has been made to follow approximately the same form as that used for corrections applied in the Canadian Standard freeness test (Fig. 6).

In setting up these corrections the respective discriminators are first balanced by setting both the "S/C gain" and "temperature gain" controls to zero and adjusting each of the temperature and S/C discriminator balance controls individually until each indicator reads zero.

Treating the corrections separately, the stock concentration correction is set up, preferably at a freeness of approximately 400 C.S. freeness as the correction reaches a peak at this value. The stock concentration is adjusted by means of the dilution water valve to 0.85% and the height of the differential transformer above the float in the stock delivery channel is adjusted to give zero reading on the stock concentration indicator with the "S/C gain" control at about half setting.

The dilution is then adjusted to 0.65% and the gain control adjusted to give an indication of −15. The stock concentration change will register immediately as a reduced recorder reading, as the correcting negative voltage becomes effective almost immediately in the transient peak voltmeter circuit. The increased drainage volume from subsequent tests at the lower stock concentration then causes the recorder pen to rise toward the original value. The degree of correction is adjusted by means of the "S/C correction" control until the recorder pen reaches the original freeness value. In normal operation the full recovery takes up to two tests.

The Canadian Standard correction curve flattens and reverses above 400 C.S. freeness, this effect has been simulated by means of a diode across the automatic gain control line to the stock concentration channel. The "A.G.C. diode bias" is adjusted so that it does not conduct until a freeness of 400 C.S. freeness is reached.

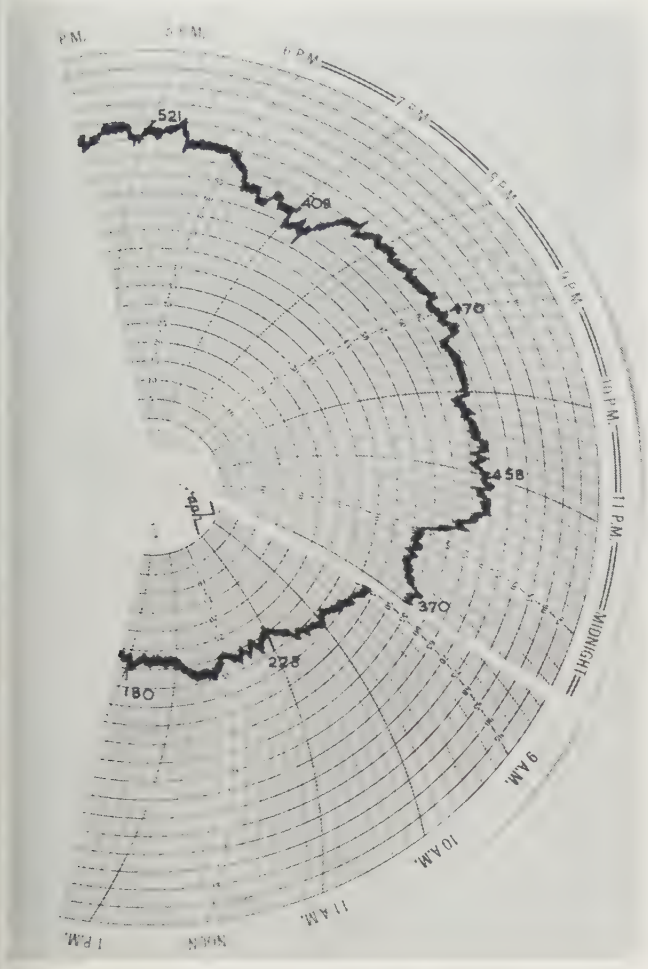


Fig. 9. Freeness charts range 0.700 C.S. freeness
C.S. freeness test results are marked at 2-hr. intervals.

Above this value the higher positive voltage derived from the freeness channel causes the diode to conduct and this prevents any further proportional increase in positive bias to the stock concentration channel. This causes the correction characteristic to flatten at 400 C.S. freeness in a reasonable approximation of the true correction curve.

For freeness values lower than 400 the correction for a given stock concentration is proportionally reduced because the gain of the amplifier is also reduced by the lower positive A.G.C. voltage from the freeness channel.

It is preferable to operate toward the lower end of the stock concentration range, e.g., at approximately 0.7 to 0.8% as better mixing is achieved to give more even stock flow and the possibility of pulp blockages occurring in the delivery tube is reduced; however the instrument has been operated at stock concentrations as high as 1.1% with effective correction being maintained. The response of the stock concentration measuring channel is shown in Fig. 7.

Correction for Temperature

The bridge is balanced with the "temperature balance" control at the temperature nominated to be the center of the range for the particular installation. The "temperature gain" is then adjusted to give a sensitivity of one division per degree centigrade on the temperature indicator.

The correction adjustment is done at 400 C.S. freeness where this characteristic reaches a peak as with

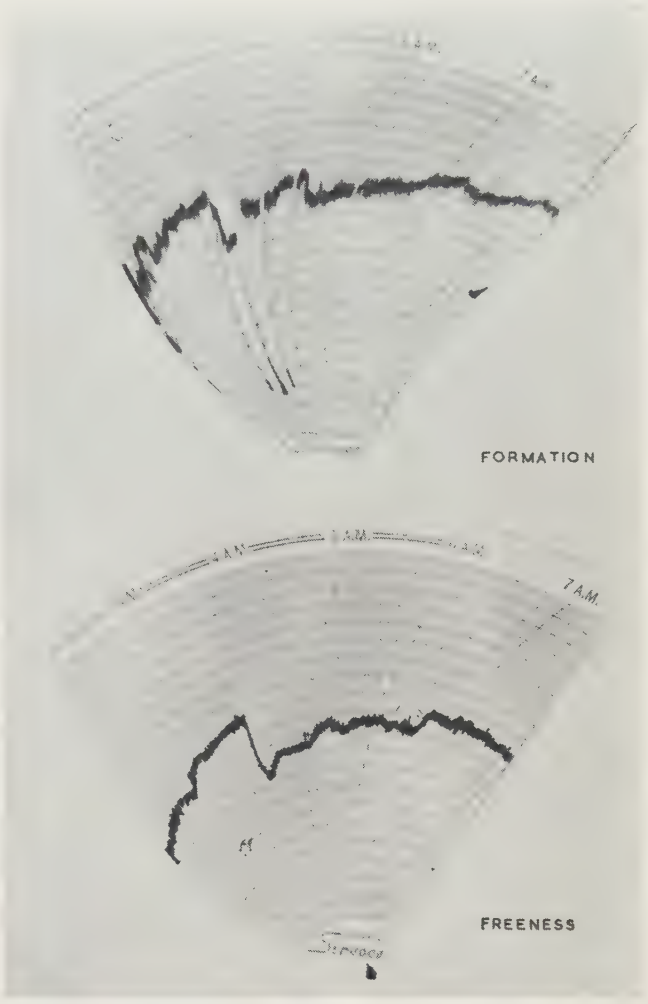


Fig. 10. Formation-freeness relation

the stock concentration correction. The degree of correction is varied by the "temperature correction" control which is adjusted until the variation in freeness reading due to any temperature change is compensated.

The ratio of temperature correction to actual freeness value is maintained automatically as described previously for stock concentration correction. The response of the temperature measuring channel is shown in Fig. 8.

Temperature variation is generally seasonal and is therefore not as important as stock concentration variation; however, the correction circuit is arranged to compensate for simultaneous changes in either variable.

Pulp and Water Requirements

In the experimental model the total pulp throughput was 18 g.p.m.; however, satisfactory operation should be maintained with a feed rate as low as 10 g.p.m. if this can be maintained without blockages

occurring at the sampling point. The stock concentration of this pulp should be in the range of 2.0 to 2.5%, and preferably nearer to 2.0%.

The water consumption is 8 to 15 g.p.m. of which $3^1/_2$ gal is required for fine sprays. This supply should be very clean and at a minimum pressure of 20 p.s.i. The rest of the water is used for dilution.

OPERATIONAL PERFORMANCE

The developmental unit has operated reliably for over twelve months on blended long and short fiber stocks over the freeness range of 180 to 580 C.S. freeness.

Sample charts covering this range are shown (Fig. 9) and, in addition, the effect of freeness variation on formation is illustrated by the corresponding chart sections of the formation and freeness recorders (Fig. 10).

The prototype of a commercial version of the instrument has operated satisfactorily on long-fiber stock over the freeness range of 200 to 750 C.S. freeness and several additional units are to be constructed for use throughout the mills of Australian Paper Manufacturers, Ltd.

The possibility of applying the instrument to the automatic control of refining is to be investigated.

PATENTS

The instrument is covered by Australian patent no. 35503/58 and overseas patents have been applied for.

LITERATURE CITED

1. Green, A. B., *The Paper Industry and Paper World* 22, No. 5: 459–462 (1940).
2. Nilson, C. N., U. S. pat. no. 2,577,712 (1951).
3. Sisler, C. O., U. S. pat. no. 2,379,835 (July 3, 1945).
4. Clark, F. C., *Paper Trade J.* 92, No. 23: 42–48 (1931).

Received Jan. 18, 1960.

The author wishes to thank Australian Paper Manufacturers, Ltd. for permission to publish this paper.

Rapid Method for Determination of Total Sulfur in Viscose

J. F. CROW, J. P. DUX, and L. H. PHIFER

A method for determination of total sulfur in viscose is described in which oxidation of the sample by combustion in a stream of oxygen at 1400°C. is used to convert all of the sulfur to the dioxide, which is then oxidized to sulfate by passing the effluent gases through a solution of hydrogen peroxide. Sulfate is determined by titration with barium perchlorate in a water-isopropanol solution, using Thorin as an indicator. The method requires approximately 30 min. for a duplicate determination, has a standard deviation of 0.02% S, and comparison with the gravimetric sulfate method shows no significant deviation with regard to accuracy.

The determination of total sulfur in viscose is one of the most important analytical control procedures in the viscose industry. For this reason a rapid method is highly desirable. Methods in the literature fall into three general classes. The first involves the simple oxidation of the viscose, in alkaline medium, with either sodium hypobromite or hydrogen peroxide, followed by the determination of sulfate gravimetrically or titrimetrically (*1*) as barium sulfate. The second method, originally devised by D'Ans and Jager (*2*, *3*) consists in determining the alkalinity before and after oxidation by peroxide, the change in alkalinity being ascribed to the oxidation of xanthate, trithiocarbonate, sulfide, etc., to sulfate. This method has been shown by Philipp (*4*) and Demus (*5*) to give high results because of oxidative attack of the cellulose, giving rise to carboxyl groups. Finally, the third category comprises those methods, used chiefly by Philipp (*4*) and Maurice (*6*) which involve the acidification of viscose (under reducing conditions in the method of Maurice) and the determination of the hydrogen sulfide and carbon disulfide evolved.

J. F. Crow, J. P. Dux, and L. H. Phifer, American Viscose Corp., Marcus Hook, Pa.

Of these three general methods, only the second is sufficiently rapid to serve as a control method, and this has been shown to give erroneous results. The method described in this paper requires approximately 30 min. per duplicate determination and is sufficiently accurate for control purposes. In brief, the method consists of a combustion of the viscose in an oxygen atmosphere in a furnace at a temperature sufficiently high to convert all sulfur compounds to sulfur dioxide. The effluent gases are bubbled through a peroxide solution to oxidize the dioxide to sulfate. The sulfate ion is titrated with barium perchlorate in 80% isopropanol using Thorin as an indicator.

The standard deviation of the method is about 0.02% sulfur. The accuracy of the procedure was determined by checking results with the well-established gravimetric sulfate method. Statistical analysis of the results indicated no significant difference between the two procedures with regard to accuracy, and subsequent experimentation showed no significant day-to-day or operator-to-operator variance.

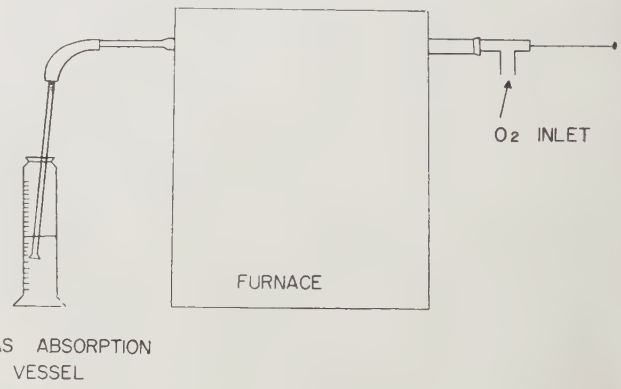


Fig. 1

EXPERIMENTAL

Apparatus. A Dietert-Detroit Varitemp was used as the combustion furnace for the method. Figure 1 is a diagram of the assembled apparatus. Zirconium base combustion tubes are used, with combustion boats of a similar refractory material. A filter disk of refractory material is placed in the constricted portion of the combustion tube to prevent mechanical carryover of material. Before use the combustion tubes are ignited in the furnace with the oxygen flowing to remove any traces of

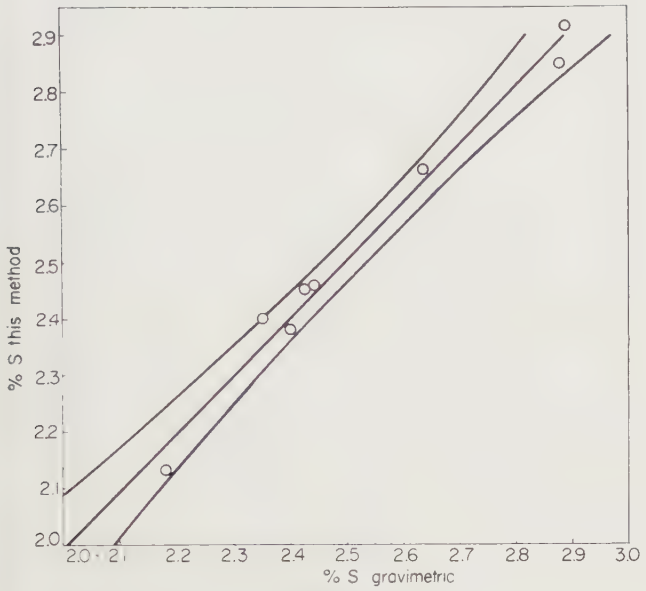


Fig. 2

sulfur. The oxygen is purified by passage through a train containing anhydrone and ascarite. The absorption vessel is a 100 ml. graduated mixing cylinder containing 25 ml. of H_2O to which 10 drops of 30% H_2O_2 have been added, while the bubbler is a glass tube with a fritted glass gas scrubber at the bottom.

Reagents.

(a). Barium perchlorate 0.005 *M*. Dissolve 2.0 g. $Ba(ClO_4)_2 \cdot 3H_2O$ in 200 ml. distilled water and add 800 ml. isopropanol. Adjust apparent pH to 3.5 with perchloric acid. Standardize against 0.005 *M* H_2SO_4 to the Thorin end point.

(b). Thorin [2-(2-hydroxy-3, 6-disulfo-1-naphthylazo) benzenearsonic acid] 0.2% solution in water. Eastman.

(c). Reagent grade 30% H_2O_2.

Procedure. The furnace is set at a temperature of 1400°C. (2600°F.). Approximately 0.1 to 0.2 g. of viscose is accurately and rapidly weighed into a combustion boat. The bubbler in the absorption vessel is connected to the outlet end of the combustion tube and the oxygen turned on at a flow rate of 2 liters per minute. The boat is inserted in the combustion tube and combustion begun. The boat is advanced in three distinct moves with about 3 min. between moves. The final move is into the hot zone where the boat is kept for at least 15 min. At the end of this time the bubbler is detached and rinsed with distilled water three times into the mixing cylinder. Water is added to the 50-ml. mark and the solution mixed. A 10-ml. aliquot is pipetted into an Erlenmeyer flask containing 40 ml. of isopropanol and 2 drops of Thorin indicator. The solution is then titrated with standard 0.005 *M* barium perchlorate solution. The end-point color change is from pale-yellow to pale-pink and, although the colors are not intense, the change is quite sharp and can be observed within a fraction of a drop.

RESULTS AND DISCUSSION

The time of a duplicate analysis run by this method is approximately 30 min. This time can be reduced, of course, if a number of determinations are run concurrently. The precision of the method as calculated from the difference between 30 pairs of duplicate analyses gave a standard deviation of ±0.016% S.

The accuracy of the method was checked by the method of Linear Calibration curves described by Mandel and Linnig (*7*). A series of eight viscoses, covering the range of 2.2 to 2.9% S, which is approximately the range of commercial rayon viscoses, was run in duplicate by both the present method and the gravimetric sulfate method. In the latter procedure, a weighed sample of viscose is dissolved in water, oxidized with alkaline sodium hypobromite solution and the sulfate determined gravimetrically as the barium salt.

Results by the two methods are given in Table I.

Table I

Sample	*S, % Gravimetric*	*S, % This method*
1	2.40, 2.40	2.38, 2.38
2	2.42, 2.46	2.43, 2.47
3	2.35, 2.36	2.43, 2.38
4	2.42, 2.43	2.45, 2.45
5	2.64, 2.65	2.68, 2.64
6	2.89, 2.87	2.85, 2.85
7	2.18, 2.18	2.12, 2.15
8	2.88, 2.88	2.90, 2.93

The results listed under gravimetric method are not true duplicates, but the results obtained on two aliquots of the same oxidized viscose. The results in the last column are on true duplicate analyses by this method. If we assume that the gravimetric sulfate method is free of error, we can use these results as representing the true total sulfur content of the viscose and apply the linear calibration curve method.

When a plot was made of the results by the new method against those of the gravimetric method the graph shown in Fig. 2 was obtained. The average of the duplicate determinations was used in this plot. If the new method were as accurate as the gravimetric method such a plot should be a straight line with a slope of unity and an intercept of zero. If a constant error were present the intercept would not be zero and if a relative error (i.e., one proportional to the sulfur content) were present the slope would be greater or less than unity. The least squares straight line, as drawn on the graph, had a slope of 1.024 and an intercept of −0.059. Calculation of the joint confidence ellipse at the 95% confidence level indicated that with this degree of confidence the slope is not significantly different from unity, nor the intercept significantly different from zero, on the basis of these data.

The two arms of the hyperbola drawn on the graph represent the 95% confidence limits as calculated by the method of Mandel and Linnig (*7*).

Finally, the method was checked for operator-to-operator and day-to-day variance by storing a sample of viscose at 0°C., to prevent loss of CS_2, analyzing at periodic intervals over a 2-month period. The results are given in Table II.

Table II

Date	Analyst A	Analyst B	Analyst C
Aug. 10, 1959	2.44, 2.45	2.47, 2.46	.. ..
Aug. 18, 1959	.. ..	.. ..	2.48, 2.50
Aug. 25, 1959	.. ..	2.48, 2.47	.. ..
Aug. 26, 1959	.. ..	.. ..	2.48, 2.50
Aug. 31, 1959	.. ..	2.50, 2.51	.. ..
Sept. 11, 1959	2.52 ..	.. ..	.. ..
Sept. 25, 1959	2.44, 2.47	.. ..	.. ..
Oct. 2, 1959	.. ..	2.44, 2.46	.. ..
Mean	2.46	2.47	2.49

The mean of all of these data is 2.47% and the standard deviation is ±0.025%. This is probably a more accurate estimate of the overall standard deviation than that determined on duplicate analyses because of the larger range of variables. There is no statistically significant day-to-day variance and no significant operator variance although analyst C may tend to give slightly high results.

With regard to interfering substances, the method is not affected by the presence of nitrogen or halogen containing substances in the viscose. This is not true of the simple iodometric titration of SO_2 which is used in the conventional Dietert sulfur determination in metals, ores, etc. (*8*).

Theoretically, in comparing *this* and the gravimetric method, the foregoing results appear to contradict the conclusion reached by Maurice (*6*). Maurice found that the gravimetric method gave consistently low results compared to the gas analysis method and a "modified complexometric method" which involved a double oxidation of the viscose followed by complexometric titration of excess barium after precipitation of barium sulfate. He theorized that this was because the ordinary alkaline oxidation of viscose by peroxide or hypobromite is incomplete, leading to the formation of some sodium dithionate, $Na_2S_2O_6$, which is not precipitable as the barium salt. However, if this were true, it is unlikely that the excellent agreement between the gravimetric and combustion procedure observed by us would have been found, since it is extremely unlikely that any dithionate would be formed in the combustion procedure. In the combustion of sulfur-containing materials at this high a temperature, not only are sulfides and other compounds containing sulfur in a low valence state converted to the dioxide, but sulfates and sulfur trioxide are reduced to the dioxide (*8*).

LITERATURE CITED

1. Flegr, K. and Berndt, W., *Faserforsch U. Textiltech.* 7: 268 (1956).
2. D'Ans, J. and Jager, A., *Cellulosechemie* 16: 29 (1935).
3. D'Ans, J. and Jager, A., *Z. Analyt. Chemie* 112: 289 (1935).
4. Philipp, B., *Faserforsch U. Textiltech.* 5: 210 (1954).
5. Demus, H., *Faserforsch U. Textiltech.* 7: 268 (1956).
6. Maurice, M., *Z. Analyt. Chemie.* 158: 410 (1957).
7. Mandel, J. and Linnig, F. J., *Anal. Chem.* 29: 743 (1957).
8. Rice-Jones, W., *Anal. Chem.* 25: 1383 (1953).

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Xanthate Sulfur Determination by the Batch Ion Exchange Method

LYLE H. PHIFER and JOAN L. BELL

A procedure has been developed for xanthate sulfur in viscose based on batch ion exchanging to remove the by-product sulfur compounds and subsequent determination of the xanthate group by ultraviolet spectroscopy. There is a considerable improvement in the time required for an analysis over the existing methods in the literature. The precision of the method is sufficient to measure the differences which occur as a result of aging viscose 2 hr. Comparative data indicate that results by the new method are more precise and in good agreement with the other methods available.

For xanthate sulfur determinations to be used for routine control, it is evident that a rapid and accurate method must be used. The methods in the literature prior to 1957 were extremely time-consuming since they were based either on precipitation of cellulose xanthate from viscose with neutral salts (*1*, *2*), or decomposition of by-product compounds with acetic acid (*3*), and subsequent determination of total sulfur as barium sulfate. An even more time-consuming but probably most accurate method involved the formation of an insoluble nitrogen-containing derivative of cellulose xanthate which is then analyzed for total nitrogen (*4*).

The first big step in method improvements was made in 1951 by Samuelson and Gärtner (*5*) when they developed a procedure based on diluting the viscose and passing it through an anion exchange resin. The divalent by-product sulfur compounds are strongly absorbed on the resin and the effluent contains the cellulose xanthate ions since they are too large to diffuse into the resin phase. The cellulose xanthate ions were then determined by direct titration with iodine.

The Samuelson-Gärtner method takes a considerable amount of time to run. An improved method was developed by Dux and Phifer (*6*) which involved the direct ion exchange of undiluted viscose and subsequent measurement of the ultraviolet absorbance of a solution of the ion exchanged viscose. This procedure takes approximately 20 min per analysis and has a precision of about ±2.8%. Although this time and precision is not considered to be excessive, a review of the procedure indicated that a further cut in the time per

Lyle H. Phifer and Joan L. Bell, American Viscose Corp., Marcus Hook, Pa.

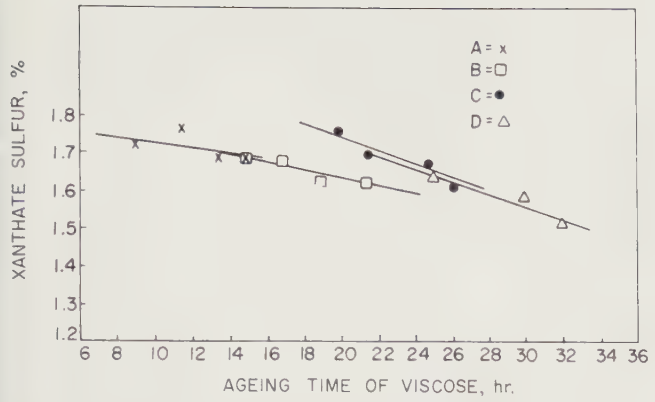


Fig. 1. Changes in xanthate sulfur during aging of viscose at 18°C.
A and B = textile type viscoses; C and D = tire yarn type.

analysis and improved precision might result from a batch ion exchange operation which would eliminate the problems associated with the use of the column. In addition, a decrease in the number of handling operations required should result in less time per analysis and improved precision.

Batch ion exchange is the simplest method of ion exchanging. Its practical use depends on the equilibrium being shifted predominantly toward the product as illustrated in the equation

$$R-Cl + X^{=} \rightleftharpoons R_2-X + 2Cl^{-}$$

where R−Cl is the chloride form of the resin and $X^{=}$ represents the by-product sulfur compounds.

The use of a batch exchange operation to remove by-product sulfur compounds was indicated when it was observed that in the column exchange of viscose the by-products were absorbed completely in the first contact portion of the resin bed and would not move down the bed on washing with sodium hydroxide. This is probably due to the fact that all of the by-product ions are divalent. Only acid, which will decompose the by-products, will remove them from the resin. Thus, there is an extremely high exchange efficiency which made the use of a batch exchange method look feasible.

This program has been carried out to study the variables associated with the batch ion exchanging method and the subsequent measurement in the ultraviolet region. The general procedure used was to disperse a weighed quantity of viscose in water or sodium hydroxide solution and add an excess of dry anion exchange resin. After equilibrium was attained, a further dilution was made, and the absorbance of the solution measured at 303 μ. The value of the absorptivity for xanthate had previously been found to be 15,900 (*6*) and no further measurements have been made of this value.

A precision requirement has been placed on the procedure such that a significant difference of xanthate sulfur values is found when there is a difference of two hours in the age of the viscose at 18°C.

EQUIPMENT AND METHODS

Equipment and Reagents

The Beckman DK spectrophotometer was used for this study. A Beckman DU spectrophotometer with ultraviolet attachment, however, is satisfactory for routine measurements.

The resins used were Amberlite anion exchange resins IRA 400 and IRA 410.

The sodium hydroxide used was reagent grade from Baker and Adamson.

Precision Requirements

The requirement was made that the final method must be able to detect a difference in per cent of xanthate sulfur as a result of a 2-hr. aging of the viscose. Samples of viscose were kept at a constant temperature of 18°C. and analyzed at time intervals. Large sample weights of the viscoses were used to obtain a more homogeneous sample. The results illustrated in Fig. 1 show that the xanthate sulfurs changed approximately 0.04% in 2 hr. In order to determine this change significantly, single xanthate values must have a standard deviation of 0.007; the mean of duplicates, 0.010; and triplicates, 0.012. Since it was intended to run duplicates, the requirement was placed on the method that the mean of duplicate determinations must have a standard deviation of not more than 0.01%.

Ion Exchanging Conditions

Choice of Resin. Approximately 2-g. samples of several viscoses were dispersed in 250 ml. of 0.1% NaOH. Aliquots of 5 ml. were pipetted into 125-ml. glass-stoppered flasks, and the samples diluted to 50 ml. with sodium hydroxide to give concentrations of 0.4 and 8.0% NaOH. IRA 400 and IRA 410 in the hydroxide form were used as the exchange resin. The resulting absorbances are given in Table I, and a higher absorbance was interpreted as lower exchange efficiency. The indication from this was that IRA 400 was better than IRA 410, particularly in the higher alkalinities.

A quantitative measure of the relative exchange efficiency was made by repeating the above experiments using the by-product sulfur compounds isolated from a viscose sample by pouring the viscose in a fine stream into 200 ml. of cold 25% NaCl solution. The results of this experiment are given in Table II. In this case the complete absence of absorbance would indicate 100% exchange of the by-product material. Since at 303 μ in commercial viscoses the by-product material contributes about a 10% error, the interference from by-product sulfur when IRA 400 is used regardless of the alkalinity up to 8% will be less than 1%.

Table I. Absorbances

		8% NaOH		0.4% NaOH	
Viscose	*Control*	*IRA 400*	*IRA 410*	*IRA 400*	*IRA 410*
A	0.550	0.495	...	0.484	...
B	0.439	0.394	0.410	0.415	0.383
C	0.400	0.368	0.379	...	...
D	0.980	0.885	...	0.740	...

Table II. Absorbance of By-Product Solution at 303 μ −0.24, 0.24

NaOH concn., %	*IRA 400*	*IRA 410*
Distilled water	0.010, 0.018	0.004, 0.004
0.1	0.018, 0.019	0.015, 0.015
1.0	0.020, 0.020	0.046, 0.040
8.0	0.029, 0.025	0.091, 0.070

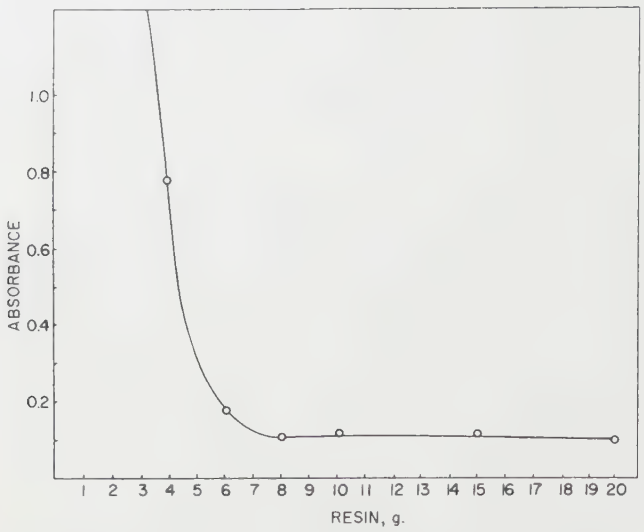


Fig. 2. Effect of varying weights of Amberlite IRA 400 on the removal of twice the amount of by-product sulfur compounds normally encountered in 0.2 g. of viscose

The effect of the chloride and hydroxide forms of IRA 400 was noted by running a series of 50-ml. aliquots from approximately 1.5-g. samples of viscose dispersed in 0.1% NaOH. These were ion exchanged with both chloride and hydroxide IRA 400 (see Table III). Since the resin comes in the chloride form and requires treatment to change it to the hydroxide, and because the chloride gives slightly more reproducible results, it was decided to use the chloride form.

Table III. Effect of Chloride and Hydroxide Forms of IRA 400 Using 0.1% NaOH as Solvent

Viscose	*Absorbance*			
	Hydroxide form IRA 400		*Chloride form IRA 400*	
1	0.373	0.359	0.370	0.379
2	1.564	1.537	1.460	1.442
3	0.272	0.270	0.258	0.268
4	1.265	1.274	1.268	1.210

Amount of Resin. To determine the minimum amount of resin necessary to remove the by-product sulfur, a concentrated solution of by-product sulfur was prepared as described before, and aliquots equivalent to twice that in spinning age viscose were exchanged with various weighed quantities of IRA 400. The results are given in Fig. 2. Seven grams of exchange resin was taken as the minimum quantity necessary to remove the by-product sulfur.

Effects of Drying Conditions on the Resin. It is required that the resin be dried to remove a large percentage of the water present. Since the resin itself may decompose under severe drying conditions, a 60°C. vacuum drying for a period of 2 hr. may be used.

Stability of Xanthate Sulfur

It is known that both temperature and alkalinity affect the stability of xanthate solutions. These variables were studied by dissolving one drop of mixer and spinning viscoses in 50 ml. of water, 0.1% NaOH, or 1% NaOH and ion exchanging with 7 g. of resin. A study of absorbance at 6°C. and 25°C., respectively, versus time was made on the solutions, and the results given in Table IV. Since 0.1% NaOH gives a change at 6°C. in 10 min., which is less than the precision of the measuring instrument, these conditions were accepted as being sufficient. The studies at higher alkali concentrations were discontinued due to the fact that exchange efficiency drops off at the higher hydroxyl level.

Table IV

Viscose	*Solvent*	*Temperature, °C.*	*Change per min. in absorbance, %*
Mixer	H_2O	6	0.055
	0.1% NaOH	6	0.053
	H_2O	25	0.465
	0.1% NaOH	25	0.266
Spinning	0.1% NaOH	6	0.053
	H_2O	25	0.294
	0.1% NaOH	25	0.090
	1.0% NaOH	25	0.080

Homogeneity Studies

Using one drop of viscose for the sample, problems arose concerning the homogeneity of the viscose itself. In order to check nonuniformity, one large sample of approximately 1 g. was dissolved in 300 ml. of 0.1% NaOH, and 50-ml. aliquots of this solution removed. Seven grams of IRA 400 were added to each, and 5-ml. aliquots were diluted to 100 ml. with 0.1% NaOH. The second series was run using a somewhat larger sample and higher dilution. Since each 50-ml. aliquot was taken from the same original sample, the results obtained should agree closely and should not be influenced by the state of the viscose.

As seen from Table V, there is much better precision here than had been achieved up to this time with single drop samples of viscose. The lack of precision in the latter case is interpreted as an indication of the heterogeneity of the viscose. To obtain a more homogeneous sample, therefore, a blending step was added to the procedure. This increased the precision so that it came within the requirements set up to distinguish between 2 hr. aging time in viscose.

Table V

Xanthate sulfur, %	*Xanthate sulfur, %*
1st series, large sample diluted	2nd series, large sample diluted
1.91	1.04
1.91	1.04
1.91	1.02
1.93	1.04
1.92	1.01
1.93 σ = 0.010	1.04
	1.04 σ = 0.012
1st series, individual drops weighed	2nd series, individual drops weighed
1.73, 1.78	1.85
1.77, 1.80	1.84
1.71, 1.83	1.69
1.77, 1.88	1.75
1.78, 1.83 σ = 0.05	1.80 σ = 0.067

Interference of Additives

The effect which additives in the viscose would have on the determination of xanthate sulfur content was determined by placing two drops of the additive in 50 ml. of 0.1% NaOH and adding 7 g. of IRA 400 resin. Five milliliters of this solution was diluted to 100 ml. with 0.1% NaOH. The results, shown in Table VI, indicate negligible absorption at 303 μ.

Table VI

Additive	*A*	*Additive*	*A*
Pycal 94	0.002	15 Dendro Phenol	0.001
50 DED	0.006	Pycal 194 or 4 Dendro Cresol	0.004
Carbowax 200	0	Cyclohexylamine	0.019
Carbowax 300	0.002	20 Dendro C.O.	0
Carbowax 400	0.001		
Carbowax 600	0.002		

Procedure for Xanthate Sulfur Determination

When a high precision is desired, the blending step is used. The viscose is chilled until its temperature is 8°C., or below. The cooled sample is placed in a Waring Blendor and mixed for 1 min., not allowing the temperature to rise above 20°C. The sample may then be cooled in the ice bath until it is ready to be analyzed. At no time should the viscose be allowed to sit at room temperature. All solutions to be used are placed in the ice bath to cool before beginning the analyses.

1. Weigh accurately one drop of the blended or unblended viscose (0.1 to 0.2 g.) into a 50-ml. Erlenmeyer flask.

2. Pipet 50 ml. of *ice cold* 0.1% NaOH into the flask on top of the sample.

3. Place flask in an ice bath until the sample dissolves. This is aided by frequent shaking. The time here varies up to 10 min., depending on the sample size.

4. As soon as the sample is dissolved, add 7 g. of dried IRA 400 resin.

5. Shake several times to ion-exchange the sample and keep in ice bath.

6. Allow the resin to settle and after 4 min. (at least 4 and no more than 8 min.) remove a 5-ml. aliquot and dilute this to 100 ml. with cold 0.1% NaOH.

7. Read *immediately* on the spectrophotometer at 303 μ, using 0.1% NaOH as the reference solution. Watch for clouding of cells.

Note: To obtain the best results all solutions must be ice-cold and all dilutions made very accurately.

Calculations:

$$\% \text{ xanthate sulfur} = \frac{64 \times 100 \times \text{absorbance}}{15{,}900 \times \text{sample weight}}$$

$$= \frac{0.4025 \times \text{absorbance}}{\text{sample weight}}$$

RESULTS AND DISCUSSION

Comparative Data Between Methods of Analysis for Xanthate Sulfur

Comparative data were obtained between the batch procedure described above and a modification of the combustion method using the Dietert furnace (*7*). (See Table VII.) This modification involved direct ion exchange of the undiluted viscose (*6*) and subsequent determination of the total sulfur.

The samples run by the ultraviolet batch method were homogenized as described in the procedure; those by the Dietert method were not. It was found that results on the same sample by the latter method sometimes had differences as high as 0.08%; this could be attributed to the previously reported heterogeneous nature of viscose.

The mean difference between the 29 samples run by the two methods was 0.004% xanthate sulfur which is less than the standard deviation of either method. Therefore, there is no significant difference between the two methods.

Table VII. Comparison of Xanthate Sulfur Procedures

No.	*Dietert, % xs*[a]	*UV batch method, % xs*	*No.*	*Dietert, % xs*	*UV batch method, % xs*
1	1.23	1.28, 1.28	16	1.35	1.29, 1.28
2	1.29	1.32, 1.33	17	1.35	1.29, 1.29
3	1.31, 1.24, 1.24	1.31, 1.34	18	1.35	1.28, 1.28
4	1.22	1.29, 1.32	19	1.31	1.24, 1.24
5	1.06	1.06, 1.06	20	1.08	1.05, 1.04
6	1.06	1.07, 1.07	21	1.06	1.08, 1.09
7	1.04	1.10, 1.10	22	1.04	1.05, 1.06
8	1.02	1.04, 1.03	23	1.02	1.05, 1.05
9	1.39, 1.36	1.29, 1.29	24	1.08, 1.07	1.08, 1.07
10	1.29	1.29, 1.28	25	1.08, 1.08	1.08, 1.08
11	1.30	1.33, 1.33	26	1.08, 1.06	1.04, 1.04
12	1.09	1.07, 1.05	27	1.11, 1.11	1.05, 1.07
13	1.07	1.04, 1.03	28	1.02, 1.04	1.03, 1.01
14	1.06	1.08, 1.07	29	1.05, 1.08	1.07, 1.10
15	1.05	1.04, 1.03			

[a] xs = xanthate sulfur.

Precision Studies

The precision of the method as it is now run meets the specifications set, i.e., a standard deviation of 0.01 to significantly detect a difference of 2 hr. of aging of the viscose. If the homogenizing step is not used, the precision of the method is somewhat lower, depending on the viscose handling conditions. This lack of precision has been used as an indication of the heterogeneity of the viscose, and multiple values on unblended samples are considered to be a measure of the situation which exists at any one time at the sampling point.

The data on duplicates obtained using the UV batch method were statistically analyzed with the following results:

1. The basic assumption is that duplicate runs give a measure of the precision of the method. It is accepted because (a) a consideration of the procedure indicates that the duplicates are independent runs, and (b) past efforts to improve the procedure have resulted in the duplicates being closer together.

2. The basic precision of the method is estimated to be: $\sigma = 0.008$.

3. The confidence interval for the mean of two runs, at 95%, is ± 0.01.

4. The range of duplicates that should be exceeded by chance less than 5% of the time is 0.04. If the range exceeds this, both duplicates should be discarded and the runs repeated.

CONCLUSIONS

Comparative xanthate data between the new batch ion exchange method and the Dietert method are in good agreement.

The precision of the batch method is sufficiently high to determine significantly a difference of 2 hr. of aging of viscose, provided the homogenization step is included or the viscose is homogeneous enough by itself. The degree of the lack of precision when the sample is not blended gives an indication of the heterogeneity of the viscose. Unblended samples thus are useful when rapid approximations (10 to 15 min.) of the

xanthate sulfur content or an indication of the heterogeneity are desired. The blending step adds about five minutes of personnel time, but due to the cooling time necessary makes the total time for an analysis 2 hr.

LITERATURE CITED

1. Barthelmy, H. L. and Williams, L., *Ind. Eng. Chem., Anal. Ed.* 17: 624 (1945).
2. Hermans, P. H., "Physics and Chemistry of Cellulose Fibers," p. 340, Elsevier, Amsterdam, 1949.
3. Geiger, E., *Helv. Chim. Acta* 13: 286, 299 (1930).
4. Fink, H., Stahn, R., and Matthes, A., *Z. Angew. Chem.* 47: 602 (1934).
5. Samuelson, O. and Gärtner, F., *Acta Chem. Scand.* 5: 596 (1951).
6. Dux, J. P. and Phifer, L. H., *Anal. Chem.* 29: 1842–1845 (1957).
7. Crow, J. F., Dux, J. P., and Phifer, L. H., *Tappi* 43, No. 7: 620 (1960).

Received Mar. 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

The Correlation and Precision of Manometric and Five-Day Biochemical Oxygen Demand in the Range of One to Twenty Parts Per Million

E. O. DILLINGHAM and A. G. JOSE

The work reported in this paper represents a further evaluation of the short-term, pure-culture manometric technique for determination of biochemical oxygen demand (B.O.D.) as a means for the prediction of long-term B.O.D. (e.g., 5-day dilution B.O.D.). The correlation and precision of manometric and 5-day B.O.D. were determined on glucose solutions, river water, and river water to which had been added different amounts of glucose in the range of 1 to 20 p.p.m. It was found that the correlation curves allowed the prediction of 5-day B.O.D. from 18-hr. manometric B.O.D. with about the same (or lower) 95% confidence limits as when using the 5-day B.O.D. alone. The advantages of the manometric correlation technique were found to be (1) rapidity of B.O.D. prediction and (2) the establishment of 95% confidence limits which are sensitive to the variation of B.O.D. of the source.

The correlation of short-term pure culture manometric biochemical oxygen demand (B.O.D.) and 5-day dilution B.O.D. for a variety of pulp and paper mill wastes was reported by Dillingham, Knuth, and Wessman (*1*). The correlation observed was adequate for the prediction of 5-day B.O.D. from manometric B.O.D. with confidence limits approximating that obtained with 5-day B.O.D. alone. In that study, river water had the lowest B.O.D. of the sources investigated. This paper reports a detailed study of the correlation and precision of manometric and 5-day B.O.D. in the range of 1 to 20 p.p.m. for river water, river water plus glucose and glucose solutions. The work represents a further evaluation of the pure culture manometric technique as a short-term method for the prediction of long-term dilution B.O.D.

E. O. Dillingham, Research Associate, and A. G. Jose, Research Aide, The Institute of Paper Chemistry, Appleton, Wis.

METHODS AND RESULTS

All manometric B.O.D. determinations were carried out at 37°C., using standardized massive inoculum of *Aerobacter aerogenes* (The Institute of Paper Chemistry strain), on a Warburg constant volume respirometer utilizing 125-ml. reaction flasks as described by Dillingham, Knuth, and Wessman (*1*).

The 5-day B.O.D. determinations on river water and river water plus glucose were carried out without the addition of inorganic salts or sewage. The initial and final dissolved oxygen were determined in accordance with "Standard Methods for the Examination of Water, Sewage and Industrial Wastes," (*2*). In the case of the glucose solutions, 1 ml. of sewage per liter was used for inoculum and 10 ml. per liter of the following salts solution was added: tribasic calcium phosphate, 0.001 g.; magnesium sulfate, 0.001 g.; monopotassium acid phosphate, 0.10 g.; ammonium sulfate, 0.25 g.; sodium bicarbonate, 30 g. per liter of solution. The

Table I. Manometric B.O.D. and 5-Day B.O.D. of Glucose Solutions

Sample no.	*Glucose added, mg./l.*	*Manometric B.O.D., p.p.m.*	*5-Day B.O.D., p.p.m.*	*Sample no.*	*Glucose added, mg./l.*	*Manometric B.O.D., p.p.m.*	*5-Day B.O.D., p.p.m.*
1	2.5	1.97	4.16	15	18.8	6.39	13.12
2	2.5	1.72	1.54	16	18.8	5.70	8.98
3	2.5	2.06	2.21	17	18.8	8.22	14.32
4	2.5	−0.21	2.08	18	18.8	6.08	14.22
5	2.5	2.62	2.30	19	18.8	7.79	13.58
6	2.5	3.81	1.94	20	18.8	7.59	14.88
7	2.5	1.69	2.01	21	18.8	6.27	13.28
8	9.4	5.07	4.98	22	31.2	13.80	16.05
9	9.4	5.05	4.94	23	31.2	12.01	17.37
10	9.4	1.21	6.57	24	31.2	14.30	23.45
11	9.4	0.98	7.69	25	31.2	11.31	24.55
12	9.4	5.08	6.24	26	31.2	12.27	23.20
13	9.4	5.54	6.14	27	31.2	13.44	23.75
14	9.4	3.24	7.54	28	31.2	13.63	23.90

Table II. Statistical Data for Glucose Solutions

Variables	n	$\bar{x}$	$\bar{y}$	b	r	95% confidence limits at $x - \bar{x} = 0$	95% confidence limits at $\lvert x - \bar{x} \rvert = 8.0$
Manometric B.O.D. (y) vs. glucose concentration (x)	28	15.5	6.4	0.39	0.95	±2.82	±2.85
Five-Day B.O.D. (y) vs. glucose concentration (x)	28	15.5	10.9	0.68	0.96	±4.20	±4.24
Five-day B.O.D. (y) vs. glucose concentration (x) (determined independently by a second operator)	20	14.65	9.32	0.61	0.96	±4.46	±4.47
Five-day B.O.D. (y) vs. manometric B.O.D. (x)	28	6.4	10.9	1.59	0.91	±6.34	±6.71

Where:
x and y are defined under variables
n = number of points
$\bar{x}$ = mean of x
$\bar{y}$ = mean of y
b = slope (regression coefficient)
r = correlation coefficient
95% confidence limits = $1.96 \times S'_r$ where
S'_r = the standard deviation of y corrected for the standard deviation of b at a given value of x.

procedure was otherwise the same as for river water.

Aqueous glucose solutions were made up in volumetric flasks a short time before use. In the case of supplemented river water samples, anhydrous glucose was added to the river water in a volumetric flask at 0 to 4°C. immediately prior to use. The small amounts of glucose added dissolved readily. Parallel determinations of manometric and 5-day B.O.D. were carried out on each of 12 river-water samples taken over a period of 10 weeks (Table III). Also included in Table III are parallel determinations on 37 river-water samples to which no glucose was added (see footnote, Table III). The confidence limits of the manometric B.O.D. for river water plus glucose (Fig. 5) are significantly greater than the confidence limits for manometric B.O.D. of pure glucose solutions (Fig. 2). The increased confidence limits for river water include a component of day-to-day variations not present in the glucose solutions. The 5-day B.O.D. confidence limits for pure glucose solutions, which received an inorganic salts supplement and sewage for inoculum, were greater than the limits for the river water B.O.D.

Tables I, II, and V give the results and statistical

Table III. Manometric B.O.D. and 5-Day B.O.D. of River Water with Added Glucose

Sample no.	Glucose added, mg./l. river water	Manometric B.O.D., p.p.m.	5-Day B.O.D., p.p.m.	Sample no.	Glucose added, mg./l. river water	Manometric B.O.D., p.p.m.	5-Day B.O.D., p.p.m.
1	0	4.0	3.9	50	1.2	6.70	5.70
2	0	2.7	3.7	51	1.2	9.18	6.10
3	0	2.8	2.0	52	1.2	7.16	5.08
4	0	1.9	5.3	53	1.2	7.72	5.35
5	0	1.4	3.0	54	1.2	5.37	5.72
6	0	1.9	5.5	55	1.2	4.48	4.60
7	0	1.6	2.8	56	1.2	8.12	4.25
8	0	0.8	3.6	57	1.2	7.30	6.78
9	0	1.8	4.0	58	1.2	6.24	5.53
10	0	1.3	3.9	59	1.2	9.88	8.43
11	0	1.4	4.6	60	1.2	8.11	5.30
12	0	1.4	4.9	61	1.2	6.90	5.65
13	0	2.0	4.8				
14	0	2.4	2.2	62	6.0	10.50	10.00
15	0	2.0	2 4	63	6.0	7.86	8.55
16	0	2.0	4.2	64	6.0	10.77	9.31
17	0	2.1	4.4	65	6.0	11.44	8.00
18	0	2.2	5.4	66	6.0	12.16	7.80
19	0	2.4	2.0	67	6.0	9.44	6.90
20	0	1.8	2.7	68	6.0	11.61	6.15
21	0	2.0	3.8	69	6.0	7.14	9.08
22	0	2.1	3.5	70	6.0	7.83	7.80
23	0	2.0	1.9	71	6.0	12.99	9.31
24	0	2.2	3.0	72	6.0	10.53	7.80
25	0	2.4	4.3	73	6.0	7.65	8.45
26	0	2.2	6.3				
27	0	10.5	4.1	74	12.0	9.52	14.01
28	0	2.5	2.1	75	12.0	9.06	11.05
29	0	2.0	2.7	76	12.0	8.34	11.25
30	0	0.8	3.1	77	12.0	10.92	11.55
31	0	1.1	2.9	78	12.0	13.62	11.00
32	0	4.8	2.9	79	12.0	12.28	10.60
33	0	2.0	3.1	80	12.0	12.33	9.50
34	0	1.9	3.0	81	12.0	7.42	11.34
35	0	1.6	3.1	82	12.0	7.40	10.80
36	0	1.7	3.2	83	12.0	13.46	12.36
37	0	1.2	3.1	84	12.0	7.74	15.20
				85	12.0	7.80	11.50
38	0	..	6.90	86	18.0	15.06	18.20
39	0	..	5.90	87	18.0	10.11	11.40
40	0	..	6.20	88	18.0	11.80	12.90
41	0	..	6.40	89	18.0	17.30	18.20
42	0	..	4.50	90	18.0	17.96	20.04
43	0	..	3.45	91	18.0	10.92	10.00
44	0	..	3.77	92	18.0	13.18	12.00
45	0	..	8.02	93	18.0	9.22	14.28
46	0	..	5.03	94	18.0	9.28	14.42
47	0	..	6.61	95	18.0	18.10	21.60
48	0	..	4.25	96	18.0	8.67	18.20
49	0	..	5.30	97	18.0	9.86	14.80

Data for samples 1 through 37 are taken from Dillingham, Knuth, and Wessman (*1*). The manometric data are corrected (see text).

Table IV. Statistical Data for River Water

Variables	n	$\bar{x}$	$\bar{y}$	b	r	95% confidence limit at $x - \bar{x} = 0$	95% confidence limit at $\lvert x - \bar{x} \rvert = 9.0$
Five-day (river water plus glucose) B.O.D. (y) vs. glucose added (x)	60	7.44	9.35	0.56	0.89	±3.78	±3.83
Manometric (river water plus glucose) B.O.D. (y) vs. glucose added (x)	48	8.93	9.97	0.32	0.72	±4.24	±4.32
Five-day B.O.D. (y) vs. manometric B.O.D. (x) for river water plus glucose	85	6.60	7.36	0.84	0.83	±5.22	±5.34

Where:
x and y are defined under variables
n = number of determinations
$\bar{x}$ = mean of x
$\bar{y}$ = mean of y
b = slope (regression coefficient)
r = correlation coefficient
95% confidence limits = $1.96 \times S'_r$ where
S'_r = the standard deviation of y corrected for the standard deviation of b at a given value of x.

data for the glucose solutions. Tables III and IV give the results and statistical data for the river water and river water plus glucose samples. Figures 1, 2, and 3 give correlation curves for the glucose solutions. Figures 4, 5, and 6 give correlation curves for the combined river water and river water plus glucose samples.

DISCUSSION

In calculating the correlation curves, homogeneity of variance was assumed within each curve over the entire range of B.O.D. investigated. The confidence intervals calculated on this assumption do not reflect the slight tendency toward increasing variance with increasing B.O.D. A more detailed study would be required to establish the magnitude of this tendency and adjust the confidence limits which would probably narrow slightly below the mean and increase slightly above it. Figures 1, 2, 4, and 5 show the repeatability of the manometric B.O.D. and 5-day B.O.D. The data in Table V plotted as open circles in Fig. 1 are data obtained by a second operator, indicating the reproducibility of the 5-day B.O.D. Table II includes the statistics for these data.

The slightly larger confidence limits for the 5-day B.O.D. to manometric B.O.D. correlation for glucose solutions as compared to river water is probably the result of the necessary addition of sewage for inoculum in the glucose solutions. The 5-day B.O.D. realized 63.6% of the theoretical B.O.D. of the glucose solutions and 77.6% of the theoretical B.O.D. of the glucose added to the river water. The manometric technique realized 36.4 and 30.0% of theoretical B.O.D. of glucose solutions and glucose added to river water, respectively, or approximately half of the 5-day B.O.D. This is consistent with data previously obtained for samples of higher B.O.D. (*1*).

The correlation curves can be used to predict long-term B.O.D. with only slightly greater to considerably

Table V. Five-Day B.O.D. of Glucose Solutions Determined Independently by a Second Operator

Sample no.	Glucose added, mg./l.	Five-day B.O.D., p.p.m.	Sample no.	Glucose added, mg./l.	Five-day B.O.D., p.p.m.
1	2.5	1.4	11	9.4	6.8
2	2.5	2.1	12	9.4	5.4
3	2.5	1.8	13	9.4	3.2
4	2.5	1.9	14	31.2	15.5
5	2.5	2.3	15	31.2	22.5
6	2.5	1.5	16	31.2	22.0
7	2.5	1.1	17	31.2	18.0
8	9.4	9.4	18	31.2	23.0
9	9.4	8.4	19	31.2	19.5
10	9.4	5.6	20	31.2	15.0

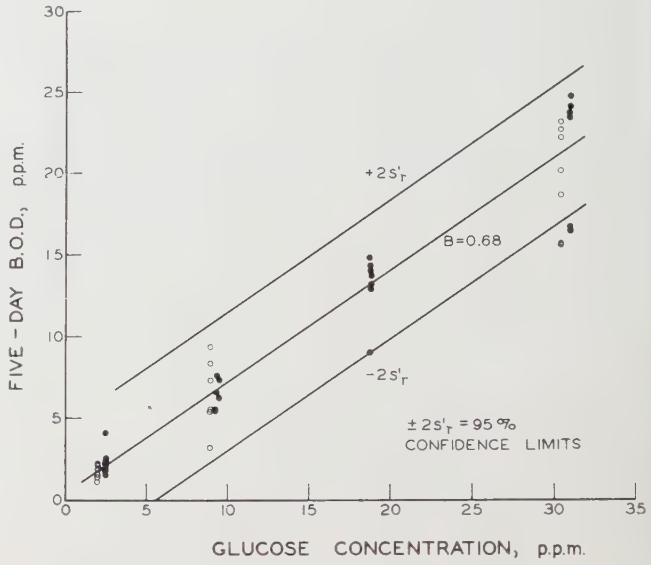


Fig. 1. Five-day B.O.D. of glucose solutions

lower confidence limits than when using 5-day B.O.D. alone. In the absence of an independent estimate of the inherent variability of the 5-day B.O.D. with respect to a given source, the entire range of observed 5-day B.O.D. must be used in the calculation of confidence limits. Considering Fig. 4, if there was no prior knowledge of the B.O.D. of the samples (the field situation) the 95% confidence limits for this group of data would be based on a range from 3 to 21 p.p.m. In order to work with reasonable confidence limits, the operator must assume an experimental variation for the 5-day B.O.D. in order to calculate a least significant difference to test significant differences between points. At any given time there is no independent evidence to aid in distinguishing true B.O.D. changes from experimental error. The advantage of the correlation curve

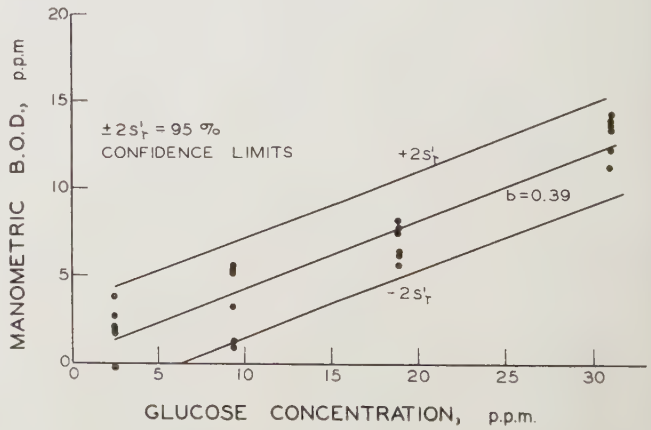


Fig. 2. Manometric B.O.D. of glucose solutions

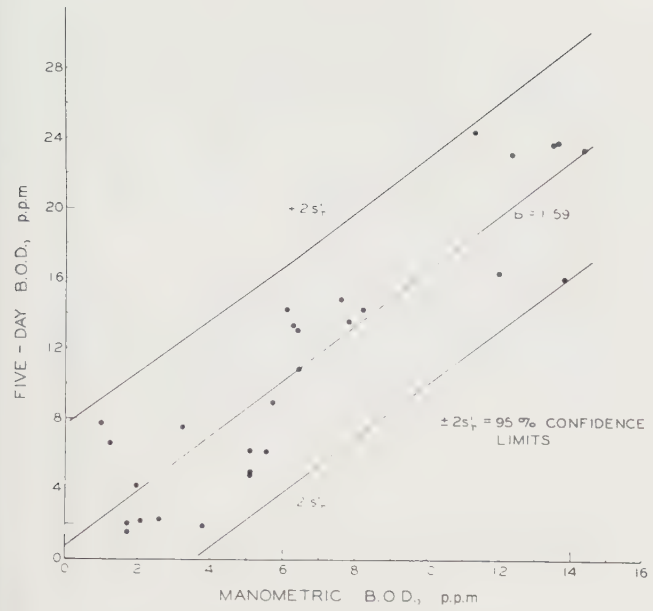


Fig. 3. The correlation of 5-day B.O.D. and manometric B.O.D. of glucose solutions

(i.e., Fig. 6) is that it is based on the total covariance of two independent techniques which allows the establishment of a well-defined upper confidence limit which is sensitive to the change of B.O.D. of the source. The greater the unpredictable variation in the B.O.D. of the source, the greater is the advantage of using the manometric correlation technique. Significant changes in the 5-day B.O.D. to manometric B.O.D. ratio (in which case the point in question would fall outside of the 95% confidence limits of the standard curve) indicates a change in composition of the source or abnormal results with one or the other B.O.D. techniques. This type of

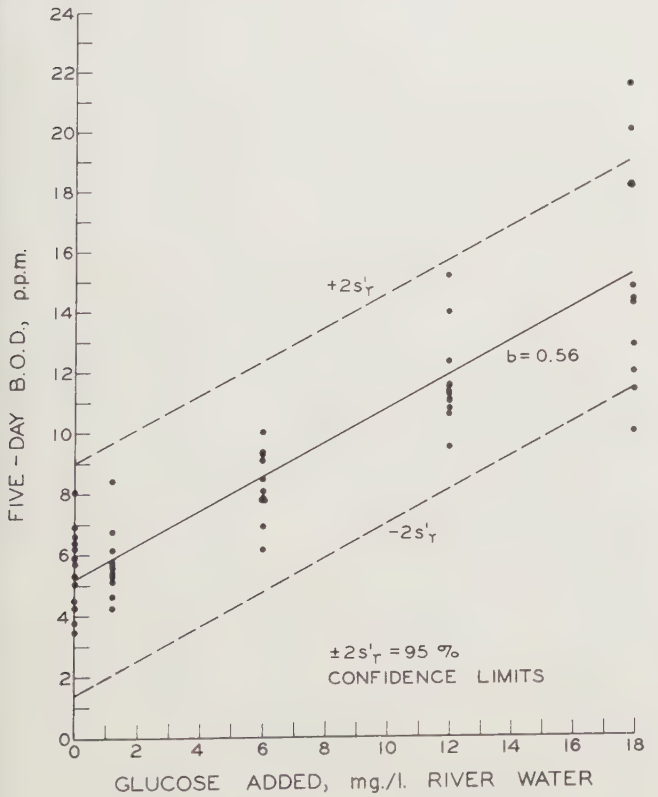


Fig. 4. Five-day B.O.D. of river water

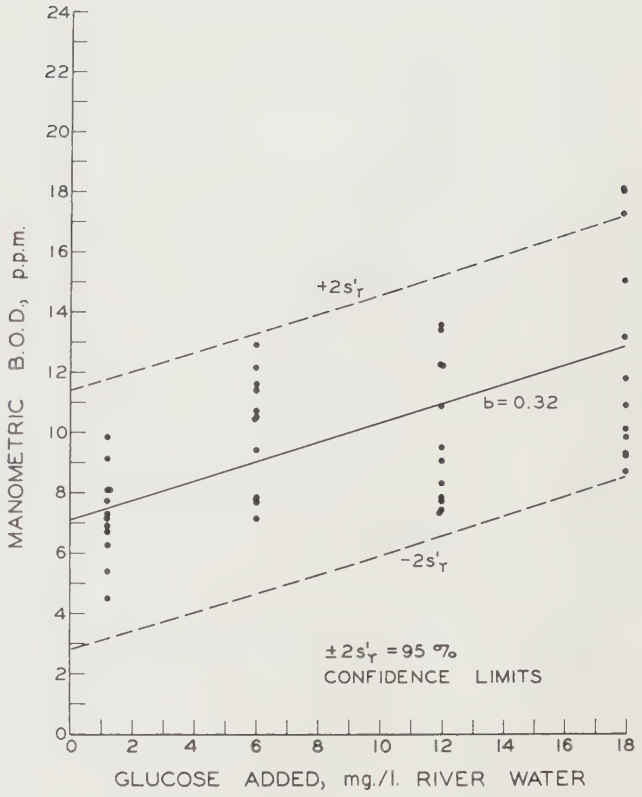


Fig. 5. Manometric B.O.D. of river water

information is not available when using a single technique. Once a sound correlation curve is established in a control situation, the manometric B.O.D. can be used to predict 5-day B.O.D., running periodic 5-day B.O.D. checks whenever there is nonstatistical reason

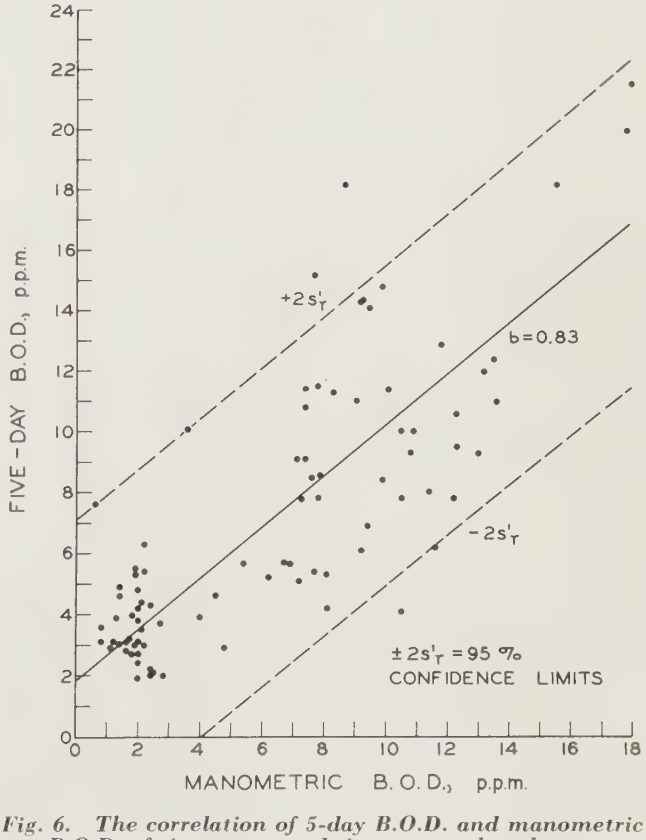


Fig. 6. The correlation of 5-day B.O.D. and manometric B.O.D. of river water and river water plus glucose

to suspect that the composition of the source has changed significantly.

Orford and Matusky (*3*) commented upon the high values for river water B.O.D. reported by Dillingham, Knuth, and Wessman (*1*). On investigation the values were found to be high by a factor of 10; the corrected values appear in Table III. The per cent of 5-day B.O.D. realized by the manometric B.O.D. in that work was actually 64.3 rather than 643. In the present work where glucose was added to river water, the per cent of 5-day B.O.D. realized was 71.4. In the light of this finding and the new data presented in this paper, the speculations of Orford and Matusky and the author concerning the reasons for the high manometric B.O.D. are not relevant.

These observations substantiate the applicability of the manometric technique for the prediction of long-term B.O.D. in the low B.O.D. range.

CONCLUSIONS

The short-term, pure-culture manometric technique provides a means of rapid B.O.D. prediction in the range of 1 to 20 p.p.m. This further confirms the applicability of the short-term manometric technique for B.O.D. prediction over the wide range of B.O.D. of interest to the pulp and paper industries.

LITERATURE CITED

1. Dillingham, E. O., Knuth, D. T., and Wessman, G. E., *Tappi* 40, No. 7: 321–333 (July, 1958).
2. "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes," 10th ed., New York, American Public Health Association, Inc., 1955, pp. 260–267.
3. Orford, H. E. and Matusky, F. E., *Sewage and Ind. Wastes* 31, No. 3: 259–267 (March, 1959).

Received Jan. 18, 1960.

We acknowledge with gratitude the help of R. B. Balch and D. A. Evans who contributed to several parts of this work.

Studies on the Nitration of *Eucalyptus rostrata*

III. Hydrolysis of Nitrated Wood*

JOSEPH A. EPSTEIN and MENACHEM LEWIN

Samples of nitrated wood of *Eucalyptus rostrata* (River Red Gum) and nitrated holocellulose prepared from the same wood were treated with 5 *N* sulfuric acid at 50, 74, and 101°C. The rate of decrease of the acetone-insoluble fraction was found to be of the first order. The energy of activation was found to be 23 kcal. per mole. The results are interpreted in terms of an alpha-cellulose—hemicellulose bond.

When a nitrating mixture consisting of nitric and phosphoric acids and phosphorus pentoxide is applied to ground and solvent-extracted wood of *Eucalyptus rostrata*, and the products of nitration are then examined at various intervals of time, several phenomena are seen to take place.

1. The amount of nitrated wood recovered from the nitrating mixture by filtration decreases rapidly at first with time of nitration, reaches a certain level and then decreases further only very slowly.
2. The solubility of this portion of nitrated wood in acetone increases with time of nitration.
3. The degree of polymerization of the fraction recovered by precipitation with water of the acetone extract of the nitrated wood rises rapidly with time of nitration, reaches a maximum and then falls off slowly.

In earlier studies (*1*, *2*) the effects of time and temperature on the process of nitration of this wood were investigated. From the results obtained it was tentatively suggested that the direct nitration of wood involves the instantaneous nitration of all components of the wood followed by several time and temperature dependent processes, which are: (1) the breaking of a bond between the alpha-cellulose and hemicellulose components; (2) the decomposition and dissolution of nitrated lignin; and (3) the depolymerization of alpha-cellulose.

From the study of the nitration process at two temperatures (3 and 20°C.) the energy of activation of process (1), which was found to be of the first order with respect to the alpha-cellulose-hemicellulose complex, was found to be 24 kcal. per mole.

The present work was carried out in order to furnish further evidence for the stipulation that the increased solubility in acetone of nitrated wood with time of nitration was due to a definite chemical change. That this change involved an intercarbohydrate link rather than a carbohydrate-lignin bond is suggested by detecting a similar phenomenon in the nitration of wood holocellulose, which contains only small amounts of lignin.

EXPERIMENTAL

A sample of wood of *Eucalyptus rostrata* was ground to pass through a 40-mesh sieve. The groundwood was successively extracted with hot alcohol and ether and dried in air. The extracted wood was nitrated with a mixture of nitric and phosphoric acids and phosphorus pentoxide, prepared according to the method of Alexander and Mitchell (*3*), at −16°C. and left for 30 min. in a refrigerator at 3°C. The nitrated wood, after being rapidly filtered, was washed with cold 50% acetic acid at −16°C. and then with cold distilled water until the washings were neutral, as determined by conductivity measurements. The nitrated wood was then repeatedly extracted with cold methanol until the washings were colorless, thus removing almost all of the nitrolignin still left in the nitrated wood. The solubility of this nitrated wood in acetone was 11%. A second sample prepared in an identical way but with leaving the nitrating mixture and the wood for 1 hr. at

Joseph A. Epstein, Research Chemist, and Menachem Lewin, Director of Research, Institute for Fibres and Forest Products Research, Ministry of Commerce and Industry, P.O.B. 8001, Jerusalem, Israel.

* For Parts I and II see (*1*) and (*2*).

Table I. Treatment of Nitrated Wood with 5 *N* H_2SO_4 at 74°C.

1	Acetone extractions[a] 2	3	4	Fraction A1 5	6	7
Hydrolysis, min.	A1,[b] g.	A2,[c] g.	A3, g.	Nitrogen, %	D.P.	D.P. cor.
0	0.081	0.732	0.19	...	...	...
120	0.083	0.701	0.22	...	1350	...
1260	0.282	0.465	0.25	13.4	1450	1850
1420	0.310	0.338	0.35	13.1	1250	1600
2700	0.442	0.231	0.33	13.0	1050	1400
3060	0.493	0.175	0.33	12.9	...	...
4200	0.562	0.102	0.34	12.8	1000	1350

[a] Extractions performed on 1 g. of treated nitrated wood.
[b] A1 corresponds to the alpha-cellulose component of the wood.
[c] A2 corresponds to the postulated cellulose-hemicellulose complex of the wood.

3°C. had an acetone solubility of 19.5%. A third sample, nitrated as above for 2 hr., had an acetone solubility of 26.8%.

The nitrated woods were treated with 5 *N* H_2SO_4 at three temperatures, 50, 74, and 101°C. In the first two cases 500 ml. of acid with 2 to 3 drops of an anionic detergent were placed in a three-necked flask in a thermostat adjusted to the required temperature. Through one of the necks a stirrer was provided. When the contents of the bath reached the required temperature, 5 of nitrated wood were rapidly introduced through the second neck, the detergent then ensuring rapid wetting and mixing of the powder in the liquid. For the acid treatment at 101°C. the flask was placed in an electric heating mantle and the third neck of the flask was connected to a water condenser. The liquid was kept at its boiling point, 101°C., at the pressure prevailing in Jerusalem (690 mm. Hg).

At various time intervals samples of liquid and powder were withdrawn with a 25-ml. pipet which had its end cut off. The samples were rapidly filtered and the powder washed repeatedly with cold distilled water until the washings, after standing overnight with the powder, had the same conductivity as the original wash water. The samples were then dried *in vacuo* over phosphorus pentoxide, weighed and extracted repeatedly with acetone. The acetone extractions were carried out under nitrogen in the dark. The acetone extracts were poured into excess of cold water to precipitate the alpha-cellulose component of the wood, (fraction A1) which was collected, dried, and weighed. The insoluble portion (fraction A2) was also dried and weighed. The difference between the sum of these two fractions and the amount taken originally gave the value of fraction A3, the acetone- and water-soluble components. In some cases the nitrogen content of fraction A1 was determined by a modified Kjeldahl method using Devarda alloy (*4*), and its degree of polymerization viscometrically in acetone at 25°C. The corrections for nitrogen content were carried out using the data of Lindsley and Frank (*5*).

Holocellulose was prepared from solvent extracted wood by the chlorite method of Wise, Murphy, and d'Addieco (*6*), five chlorite treatments being employed. The lignin content of the holocellulose, determined by the TAPPI Standard T 222 m-54 was 4.5%. The holocellulose was nitrated for 30 min. in the same way as the wood, and the product had an acetone solubility of 44.5%. Treatments of the nitrated holocellulose with 5 *N* H_2SO_4 at 75 and 101°C. were carried out in the same manner as described above.

RESULTS AND DISCUSSION

The results are given in Tables I and II and shown graphically in Fig. 1, 2, 3, and 4. Table I gives the detailed results of one typical experiment, namely the treatment of nitrated wood with acid at 74°C. Fraction A1 corresponds to the alpha-cellulose component of the wood. Fraction A2, the acetone insoluble portion, corresponds to the postulated cellulose-hemicellulose complex of the wood.

Table II gives a summary of the results of several such acid treatments. The value of k, the first-order reaction constant, was calculated by the method of least squares from the values of the weights of fraction A2. The last two columns give the nitrogen content of fraction A1 at the beginning and at the end of the experiment.

The values of the various A2 fractions are drawn as log plots for all the experiments in Fig. 1 and 2. The starting material for the treatment of nitrated wood at 74°C. was initially nitrated for a longer period than the others hence, as shown earlier, had an initial higher acetone solubility.

The holocellulose has an initial acetone solubility of 44.5% showing that a large amount of the complex is decomposed during the preparation of the holocellulose, i.e., during the chlorite treatment at pH 4 and 70°C.

These plots may be regarded as first-order reaction rate plots. It is assumed that the acid causes a cleavage of a bond between the alpha-cellulose and hemicellulose components of the nitrated wood. Prior to this, the nitrated alpha-cellulose cannot be dissolved in acetone. Hence the value of the acetone insoluble fraction can be taken to represent the unreacted material, i.e., representative $(a - x)$ in the first-order rate equation:

$$k = \frac{2.303}{t} \log \frac{a}{a - x} \cdots 1$$

where k is the reaction rate constant and t the time of hydrolysis.

Table II. Summary of Results of Acid Treatment of Nitrated Wood and Holocellulose

Material	Temp., °C.	Time of nitration, min.	k,[a] min.$^{-1}$ × 10^4	Fraction A1 D.P. Before treatment	D.P. After treatment	Acid treatment, hr.	Nitrogen, % Initial	Nitrogen, % Final
Nitrated wood	50	30	0.142	1000[b]	1000[b]	74	13.4	...
"	74	60	4.70	1850	1350	70	12.8	13.4
"	101	30	28.8	1900	970	8.5	12.6	13.5
Nitrated holocellulose	75	30	4.91	1150[b]	800[b]	47	...	...
"	101	30	37.7	1150[b]	530[b]	8	...	...

[a] Calcd. from weights of fraction A2.
[b] Values not corrected for nitrogen content.

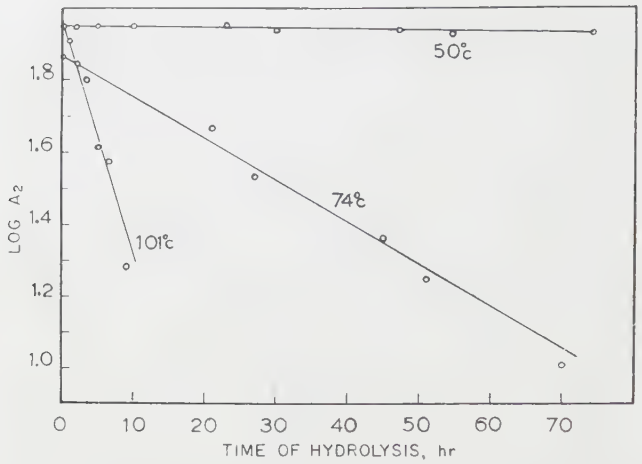


Fig. 1. Hydrolysis of nitrated wood with 5 N H_2SO_4 at 50, 74, and 101°C.

A_2 = acetone-insoluble fraction.

Figure 3 is a plot of log. k vs. $1/T$, where T is the absolute temperature of the reaction, for both nitrated wood and holocellulose. The value of the activation energy of this process calculated by the method of least squares from the points in this figure, is 23 kcal. per/mole which may be compared with the value of 24 kcal. per/mole obtained in an earlier study (*2*) on the effect of temperature on the nitration of wood. In spite of the differences between the two systems the similarity in this value may be taken to indicate the similar nature of the reaction taking place in the two processes, and to furnish further evidence for the suggestion that the nitration of the wood involves the breaking of a chemical bond between the alpha-cellulose components of the wood. The nitrated wood complex is thereby split into its two parts: the alpha-cellulose is obtained as fraction A1 whereas the hemicellulose is obtained as fraction A3. As seen from Table I, the yields of both these fractions increase in a parallel way with the decrease in fraction A2.

From the results shown in Table I, columns 5–7, it may be seen that the acid treatment brings about a decrease in both the degree of polymerization and the nitrogen content of the nitrated alpha-cellulose. The decrease in nitrogen content is small and may be due to a different cause than the acid treatment, as will be

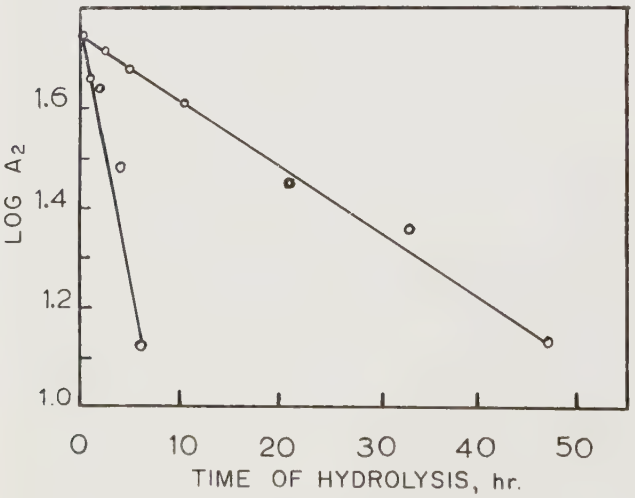


Fig. 2. Hydrolysis of nitrated holocellulose with 5 N H_2SO_4 at two temperatures

A_2 = acetone-insoluble fraction.

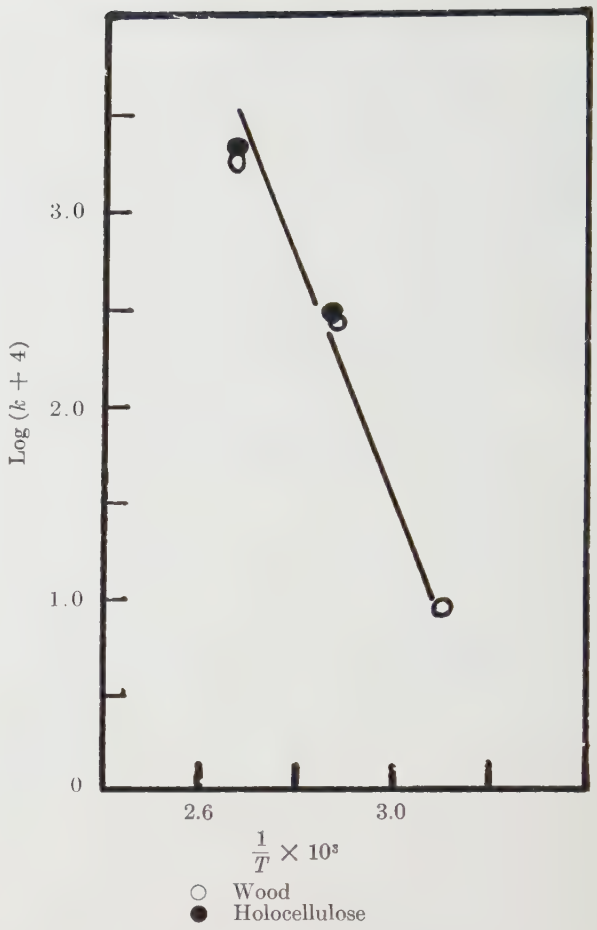


Fig. 3. Plot of log k vs. 1/T for the acid hydrolysis of nitrated wood and holocellulose

shown later; but the decrease in degree of polymerization is considerable. The data in Table II show that this decrease is strongly affected by the temperature—at 50°C. there is no degradation, at 74°C. the decrease is nearly one third, whereas at 101°C. the decrease is nearly one half. The degradation is, in fact, even more extensive since the increase in the amount of fraction

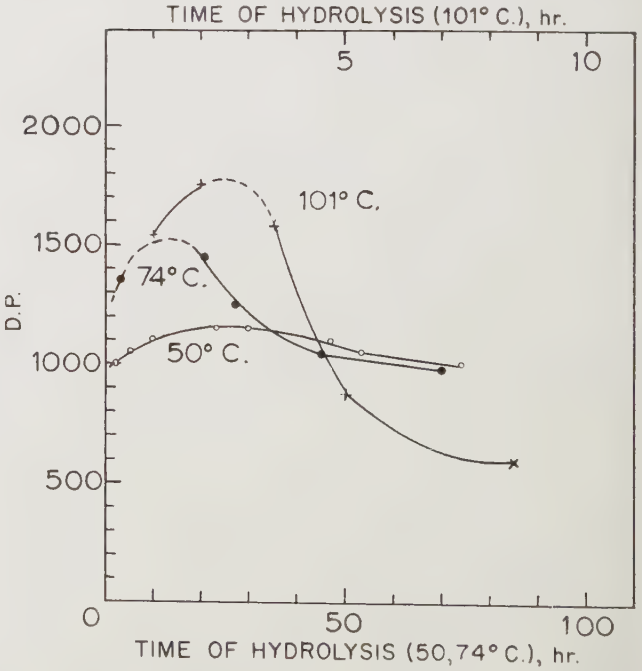


Fig. 4. Effect of time of hydrolysis at 50, 74, and 101°C. on the D.P. of fraction A1 of nitrated wood

Table III. Comparison of Behavior of Wood on Nitration and Hydrolysis

Nitration of wood			Hydrolysis of nitrated wood		
Temp., °C.			Temp., °C.		
		Degree of Polymerization			
3	Initial	1250	50	Initial	1300
	Maximum	2700	75	Initial	1850
	Final	1950		Final	1350
20	Initial	3000	101	Initial	1900
	Final	2540		Final	970
		Nitrogen Content, %			
3	Initial	12.8	50	Initial	13.4
	Maximum	13.8	74	Initial	13.4
	Final	13.6		Final	12.8
20	Initial	13.2	101	Initial	13.5
	Maximum	13.9		Final	12.6
	Final	13.8			
		k, min.$^{-1}$ × 10^4			
3		0.276	50		0.142
			74		4.70
20		3.21	101		28.8
		E, kcal./mole			
3–20		24	50–101		23

A1 should lead to higher degrees of polymerization than those obtained initially, according to the postulation (*2*) that the shorter chains are more likely to be released from the complex at the early stages. The combined result of this effect and of the depolymerization effect leads in the case of nitration to the initial increase in D.P. with time of nitration reaching a maximum and followed by a decrease. Such an effect is noticed to a small extent in the present study. The D.P.s of the A1 fractions of the hydrolyzed wood are plotted against time of hydrolysis in Fig. 4. The effect is strongest at the highest temperature, but is also apparent at the other two temperatures.

At the end of the experiment shown in Table I, over 50% of the nitrated wood is obtained as cellulose nitrate of nitrogen content 12.8%. This substantiates the statement made in the earlier studies (*1*) that the increased solubility of the wood with the time of nitration is not due to gradual nitration. For if this was the case, the alpha-cellulose separated from the acetone insoluble fraction of the wood would have to have a low nitrogen content, sufficiently low to cause insolubility in acetone. The separation from this fraction of over 50% of alpha-cellulose of nitrogen content 12.8% proves that this portion of the wood is completely nitrated during the period of nitration employed in the present work, viz., 30 and 60 min.

The decrease in nitrogen content during the hydrolysis from 13.4 to 12.8% at 74°C. and from 13.5 to 12.6% at 101°C., may be due to two causes: the saponification of nitrate groups by the acid and/or the release of free hydroxyl groups previously engaged in forming the intercarbohydrate link. Not much is known about the saponification of nitrate groups in cellulose nitrate by acids at elevated temperatures. Guncotton of 13% nitrogen boiled with water for 18 hr. is generally accepted to lose about 0.15% of its nitrogen and it is thought that this loss is due to traces of sulfuric acid which this treatment removes from the guncotton (*7*). A careful study of this effect by Chedin and Tribot (*8*) quoted by Miles (*7*) showed that the loss of nitrogen in boiling guncotton of 13.2% N_2 content in water for 90 hr. was 0.62% N_2 and consisted of two parts: a constant loss independent of sulfuric acid, and an initial loss presumably caused by the sulfuric acid washed out of the fibers. The decrease in nitrogen content in the present work may therefore be due to both the causes mentioned above.

In Table III a comparison is made between the main features of the nitration of wood and the hydrolysis of nitrated wood.

The problem of the nature of the association of noncellulosic carbohydrates with alpha-cellulose in wood and similar natural substances has aroused some interest in recent years.

Earlier work is summarized by Hermans (*9*). The high carboxyl content of wood cellulose is ascribed in part to the fact that in wood the cellulose is chemically linked with other constituents of the wood through the carboxyl group. The work of Staudinger (*10*) on the nitrates of native cellulose has given him reason to presume that native cellulose contains bonds in the form of esters. Hess and Steurer (*11*) suspected the presence of chemical cross-links between the chains. Ekenstam (*12*) expressed a similar view and assumed that the rupture of these links is a necessary preliminary to the dissolving of native cellulose at all. Further observations which might point to chemical cross-links were made by Signer (*13*) and by Opderbeck (*14*). Schmidt and co-workers (*15*) are of the opinion that in beechwood pulp xylan is built into the cellulose chains. Astbury and co-workers (*16*) think that short xylan chains are built into the lattice of cellulose by a process of mixed crystallization.

Most of the recent work has, however, been concerned with the actual separation and identification of various fragment of sugars. Several papers have, however, been published dealing with the matter from a kinetic point of view. Bernardin (*17*), in a study of the extraction of hemicellulose from black gumwood with water at 160°C, finds that the process does not follow any kinetic law, and suggests a diffusion mechanism. Booker and Schuerch (*18*), in a similar study on the rate of extraction of pentosans from woody tissues by alkali of varying strength at several temperatures, state that it is not clear whether their results should be interpreted to mean that a covalent bond must be broken by a temperature dependent process. In another study (*19*) on the effect of particle size, alkali concentration and temperature on the rate of extraction of pentosans from birch wood, Nelson and Schuerch concluded that the factors which inhibit the removal of pentosans are physical.

Indirect indication of the existence of definite chemical bonds between cellulose and noncellulosic carbohydrates may be derived from the study of polysaccharides associated with alpha-cellulose. Adams and Bishop (*20*) found small amounts of xylose, arabinose, mannose, galactose, ribose, and rhammose in carefully purified alpha-cellulose from cotton, wheat straw, hardwood pulp, and bacterial cellulose. Anthis (*21*) isolated a disaccharide containing mannose and glucose in purified slash pine alpha-cellulose, showing the presence of a mannose-glucose link in wood cellulose. The persistence of wood xylan and mannan through successive treatments of pulp was investigated by Mitchell (*22*). The structure of gluco-mannans from sitka spruce, western hemlock, and white birch has been studied by Dutton and Hunt (*23*), Hamilton and Kirchner (*24*) and by Gillham and Timell (*25*), respectively.

It seems therefore that there is a possibility of the

existence in wood of definite covalent bonds between cellulose and other polysaccharides. These bonds may not be sufficiently strong to affect the rate of extraction of pentosans from wood in alkali solution. The method used in the present work is more suitable for kinetic studies of this problem. Dymling, Giertz, and Ranby (*26*) have attempted to separate wood carbohydrates from cellulose in delignified pulp by nitration and fractional dissolution of the nitrates in mixtures of ethyl acetate and ethanol of varying proportions. The application of the nitration method as an analytical tool in the study of wood pulp was first suggested by Brissaud and Ronssin (*28*). The method described here provides a new approach to the study of the problem of intercarbohydrate links in naturally occurring cellulosic materials.

LITERATURE CITED

1. Lewin, M. and Epstein, J. A., *Tappi* 41: 240 (1958).
2. Lewin, M. and Epstein, J. A., *Tappi* 42: 549 (1959).
3. Alexander, W. J. and Mitchell, R. L. *Anal. Chem.* 21: 1947 (1949).
4. Dorée, C., "The Methods of Cellulose Chemistry," London, Chapman and Hall, 1950.
5. Lindsley, C. H. and Frank, M. B., *Ind. Eng. Chem.* 45: 2491 (1953).
6. Wise, L. E., Murphy, M., and d'Addieco, A. A., *Paper Trade J.* 122: 1 (1946).
7. Miles, F. O., "Cellulose Nitrate," London, Oliver and Boyd, 1955, p. 268.
8. Chedin and Tribot, *Mem. des Services Chim. l'Etat* 32: 157 (1946); *see* ref. 7.
9. Hermans, P. H., in "Physics and Chemistry of Cellulose Fibres," Elsevier, 1949, p. 85.
10. Staudinger, H., *Cellulosechem.* 15: 66 (1934); *see* ref. 9.
11. Hess, K. and Steurer, E., *Ber.* 79: 669 (1940); *see* ref. 9.
12. Ekenstam, A. af., *Ber.* 69: 549, 553 (1936); *see* ref. 9.
13. Signer, R. and Gross H. Z., *Physik. Chem.* 165: 161 (1933); *see* ref. 9.
14. Opderbeck, F., *Ann. Reports Chem. Soc.* 36: 271; (1939), *see* ref. 9.
15. Schmidt, E., *et al.*, *Cellulosechem.* 13: 120 (1932); *see* ref. 9.
16. Astbury, W. T., *et al.*, *Nature* 136: 391 (1935); *see* ref. 9.
17. Bernardin, L. J., *Tappi* 41: 491 (1958).
18. Booker, E. and Schuerch, C., *Tappi* 41: 650 (1958).
19. Nelson, R. and Schuerch, C., *J. Poly Sci.* 21: 435 (1956).
20. Adams, G. A. and Bishop, C. T., *Tappi* 38: 672 (1935).
21. Anthis, A., *Tappi* 39: 571 (1956).
22. Mitchell, R. L., *et al. Tappi* 39: 571 (1956).
23. Dutton, G. G. S. and Hunt, K., *J. Am. Chem. Soc.* 80: 5697 (1958).
24. Hamilton, J. K. and Kircher, H. W., *J. Am. Chem. Soc.* 80: 4703 (1958).
25. Gillham, J. K. and Timell, T. E., *Svensk Papperstidn.* 61: 540 (1958).
26. Dymling E., Giertz, A. W., and Ranby, B. G., *Svensk Papperstidn.* 178: 10 (1955).
27. Bryde, Ø., Ellefsen, Ø., and Smith, T. H., *Tappi* 36: 353 (1953).
28. Brissaud, L. and Ronssin, S., *Bull. Assoc. tech. ind. papetiere* 4: 107 (1953).

Received Jan. 7, 1960.

The Oxidation of the ICCA Pulps with Lead Tetraacetate

RICHARD W. DETRICK

An investigation was made in order to extend the work initiated by Steinmann and White (*11*) who suggested that mannose units in wood pulps were selectively oxidized by lead tetraacetate in glacial acetic acid. The effects of temperature and concentration were investigated and the eight ICCA pulps then were oxidized under more drastic conditions than those employed by Steinmann and White. Analyses of the oxidized pulps showed that a selective removal of mannose units took place during the oxidation. In addition, a smaller but significant removal of xylose units was found [thus confirming the work of Roudier and Nick (*13*)]. The importance of the degree of polymerization and the accessibility of the pulps was investigated and found to have an influence secondary to that of the mannose unit content of a pulp. Erythrose, the ultimate degradation product of a 2,3-glycol oxidation of a hexose unit, was identified in a hydrolyzate from the oxidized pulp. Analyses of the oxidation solution and determinations of yield supported the postulate that the mechanism of the sugar removal was not oxidation alone but rather an oxidation followed by a limited hydrolysis or solution of the sugar units in the more accessible portions of the oxidized pulp.

The investigation of the lead tetraacetate oxidation of carbohydrates was initiated by Criegee (*1–3*) on sugars and extended to sugar derivatives by Hockett and collaborators (*4–9*); both investigators found that lead tetraacetate in glacial acetic acid oxidized glycols to pairs of carbonyl groups at rates that were greater for *cis*- than *trans*-isomers and were dependent upon the particular glycol examined.

Upon the extension of the investigation to oligosaccharides, Perlin (*10*) encountered glycol groups which resisted oxidation; such groups were the 2,3-*trans*-glycols of *central* residues which were linked to adjacent residues by 1,4-glycosidic bonds. The 2,3-*trans* glycol groups of the reducing and nonreducing ends were readily oxidized and therefore, as suggested by Perlin, the end groups were sensitive to oxidation.

In a heterogeneous system, Steinmann and White (*11*), in 1954, investigated the tetraacetate oxidation of bleached wood pulps in glacial acetic acid and showed a correlation between the mannose unit content of a pulp and the initial, rapid consumption of lead tetraacetate by the pulp.

Matsuzaki and Ward (*12*) confirmed the correlation obtained by Steinmann and White. After a determination of the sugar units content of the pulps both before and after oxidation, the authors stated that no specific oxidation of mannose units took place. They hypothesized that variations in the initial consumption of oxidant that occurred among different wood pulps during the tetraacetate oxidation might be correlated with the accessibilities or with reactions involving the end groups of the pulps.

Roudier and Nick (*13*) found mannose units to be slightly attacked during the tetraacetate oxidation. The authors also found that xylose units in the pulp were oxidized and that the oxidation, therefore, was not specific for mannans. They believe that the accessibility of a pulp is an important influence in governing the extent of the tetraacetate consumption.

THE OXIDATIONS AND CORRELATIONS

In order to shed light on the existing literature, the eight ICCA (International Committee for Cellulose Analysis) "standard" pulps were oxidized with lead

Richard W. Detrick, Graduate Student, The Institute of Paper Chemistry, Appleton, Wis.; present address, Thilmany Pulp and Paper Co., Kaukauna, Wis. Work performed at The Institute of Paper Chemistry.

Table I. Characterizations of ICCA Pulps[a]

Pulp no.	Description of pulp	Total determined sugars, weight %: Glucose, %	Mannose, %	Xylose, %	Sorption ratio[b]	Trinitrate intrinsic viscosity, dl./g.
1	Cotton linters	99.5	0.0	0.5	1.00	29.9
2	Sulfite pulp, acetate grade	98.5	0.4	1.1	1.14	19.7
3	Prehydrolyzed kraft	97.9	1.0	1.1	1.32	14.2
4	Sulfite softwood pulp, rayon grade	95.3	2.5	2.2	1.18	15.0
5	Sulfite pulp, cellophane grade	96.1	2.5	1.4	1.15	10.3
7	Sulfite pulp, paper grade	87.9	7.5	4.6	1.37	22.9
8	Sulfite pulp, greaseproof grade	83.5	11.4	5.1	1.35	29.1
9	Sulfite pulp, birch, rayon grade	95.1	1.1	3.8	1.16	14.3

[a] The experimental methods that were used in these characterizations are given in a previous paper (*14*).
[b] The sorption ratio may be defined as the moisture regain of the pulp sample divided by the moisture regain of pulp no. 1, cotton linters.

tetraacetate in glacial acetic acid. Prior to oxidation, the pulps were characterized by determinations of their accessibilities (sorption ratios), sugar units contents, and trinitrate intrinsic viscosities. These characterizations are given in a previous paper (*14*). These data are summarized in Table I.

In a series of preliminary investigations, pulp no. 8 was oxidized at temperatures of 30 and 50°C. and at concentration ratios [moles tetraacetate/mole anhydroglucose (162 g. pulp)] of 4/1, 2.5/1, and 1/1. Figures 1 and 2 show these results.

It can be seen from Figs. 1 and 2 that temperature has a pronounced influence upon the extent of the oxidation while the effect of concentration is very slight.

Table II. Consumption of Lead Tetraacetate
(Extrapolated to Zero Time)

Pulp no.	Moles lead tetraacetate × 10^2 consumed per 162 g. pulp (extrapolated value)
1	0.26
2	0.76
3	0.27
4	1.08
5	0.85
7	2.14
8	3.07
9	0.76

The eight ICCA pulps were then oxidized at 50°C. using a concentration ratio of 1/1. [It should be noted that the oxidation conditions are more drastic than those employed by previous investigators (*11–13*)—namely, an oxidation temperature of 30°C. and a concentration ratio of approximately 1/4.] The eight oxidation curves are given in Fig. 3.

By an arbitrary extrapolation to the ordinate from the linear portions of the curves (as shown in Fig. 3), extrapolated consumption values (at zero time) of the oxidant were obtained. [This extrapolated value has been termed the "rapid initial consumption" by Steinmann and White (*11*).] These values are given in Table II. In Figs. 4 and 5, the mannose and xylose unit percentages of the pulps are plotted versus these extrapolated values.

It can be seen that a very high correlation is obtained between the mannose unit percentage and consumption of oxidant. For the six sulfite pulps only (pulp nos. 2, 4, 5, 7, 8, and 9), the correlation coefficient between the mannose unit percentages and the extrapolated values of tetraacetate consumption is 0.992.

Instead of using the extrapolated values of the tetraacetate consumption, when the tetraacetate consumed after 600 min. of oxidation was plotted versus the xylose unit percentages, an excellent correlation coefficient (0.978) was obtained. When these consumption values were plotted versus the mannose unit percentages, the correlation coefficient decreased to 0.901.

In Fig. 6, lead tetraacetate consumption (extrapolated values) was plotted versus the trinitrate intrinsic viscosities of the pulps in order to ascertain the influence of D.P. (and to obtain an approximate measure of the influence of end groups). In Fig. 7, the consumption of oxidant was plotted versus the sorption ratios of the pulps (a measure of accessibility).

It is seen that poor correlations are obtained in both plots. A statistical analysis shows (with the data of Figs. 6 and 7) that linear regression cannot be assumed and that no *straight* lines should be drawn. It should

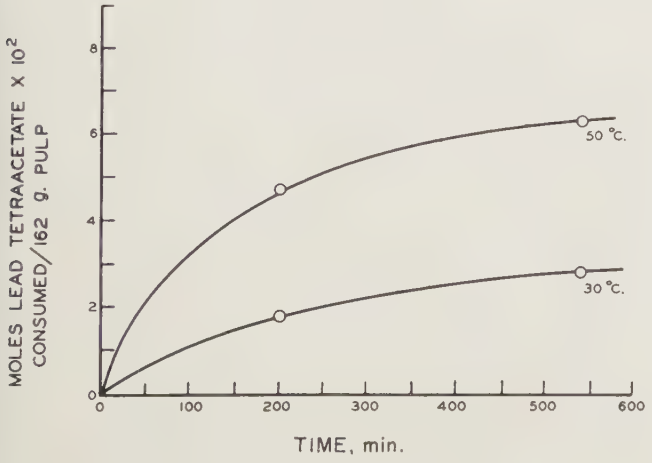


Fig. 1. The effect of temperature upon the oxidation

Pulp no. 8: concentration ratio = 4:1 (mole tetraacetate:mole anhydroglucose unit)

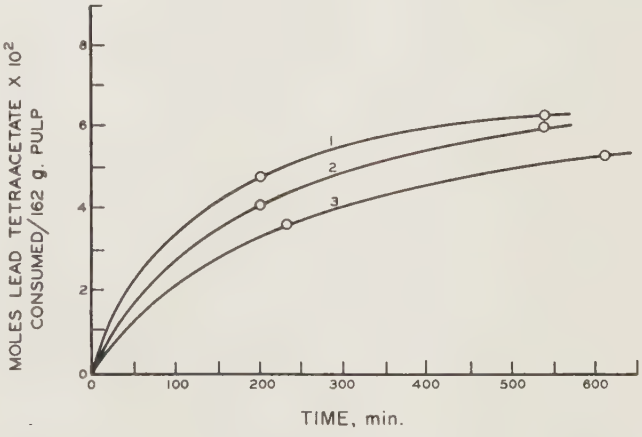


Fig. 2. The effect of concentration upon the oxidation

Pulp no. 8: temperature = 50°C. concentration ratios (mole lead tetraacetate: mole anhydroglucose unit) = curve 1, 4:1; curve 2, 2.5:1; and curve 3, 1:1.

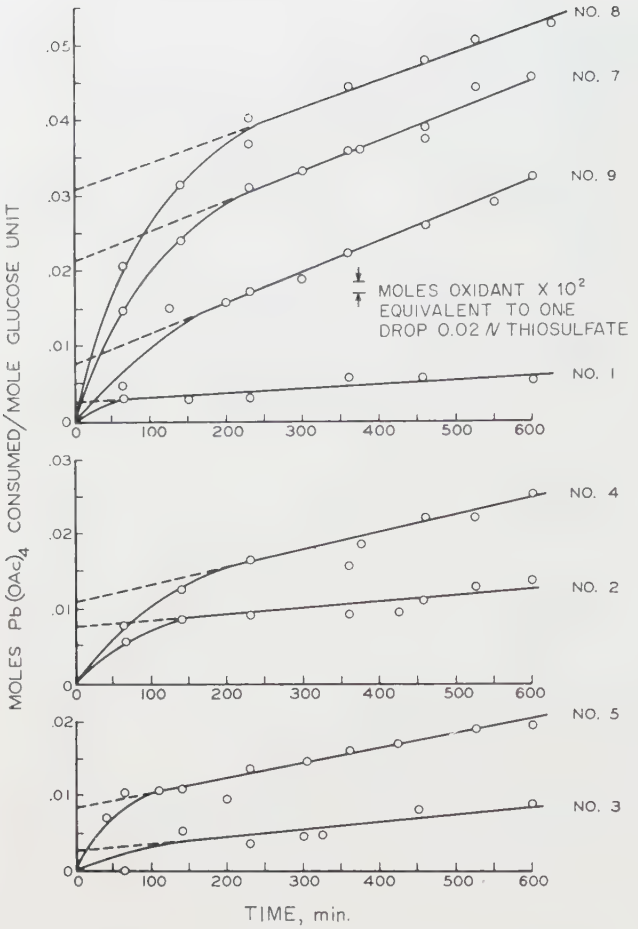


Fig. 3. The oxidation of the ICCA pulps

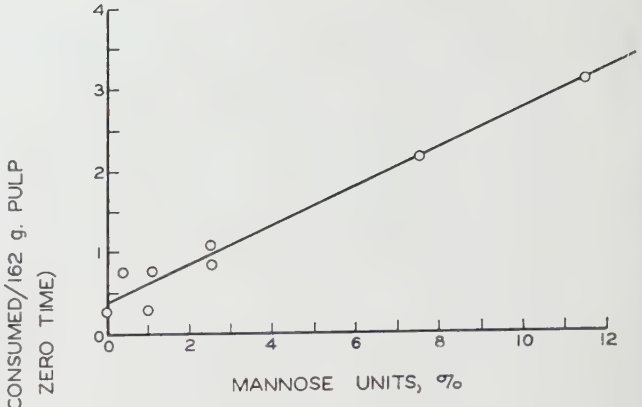


Fig. 4. Influence of mannose unit percentage upon tetraacetate consumption

Correlation coefficient (γ) = 0.981

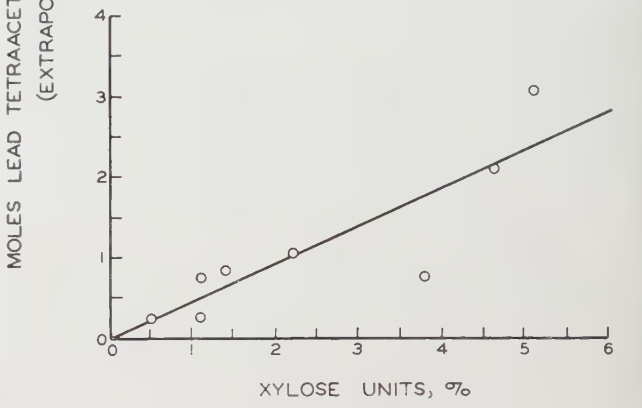


Fig. 5. Influence of xylose unit percentage upon tetraacetate consumption

Correlation coefficient (γ) = 0.866

be noted, however, that, if the point representing pulp no. 1 in Fig. 6 and the point representing pulp no. 3 in Fig. 7 were omitted, and revised straight lines were plotted, tests for linear regression would be positive and the correlation coefficients for Figs. 6 and 7 would be 0.88 and 0.92, respectively. Thus, the correlations are quite sensitive to a single "scattered" point; it is seen, therefore, that it could *not* be concluded that accessibility (sorption ratio) and degree of polymerization are unimportant merely from the data of Figs. 6 and 7.

It is interesting to note, however, that the slopes of both the original and revised lines in Fig. 6 (consumption of oxidant *versus* trinitrate viscosity) are contrary to that which would be expected from a review of the previous literature (*10, 12*); i.e., the higher the viscosity (the fewer the number of end groups), the *greater* the oxidation.

ANALYSIS OF OXIDIZED PULPS

By following the same technique described in detail in a previous paper (*14*), the sugar unit contents of selected oxidized pulps were determined quantitatively by a chromatographic, spectrophotometric method. Tables IIIa and IIIb list the results of these analyses.

The mean yield value for each oxidized pulp was also obtained and is listed in Tables IIIa and IIIb. A considerable amount of "scatter" was found in the yield data for each pulp—there being no correlation between the yield percentage data and time of oxidation. The yield values will be discussed in more detail later on in this paper.

Using the mean yield percentage figures and the sugar unit percentage data of Tables IIIa and IIIb, the percentages of glucose, mannose, and xylose units that were removed during the oxidation process were calculated and are presented in Table IV. Also given are the

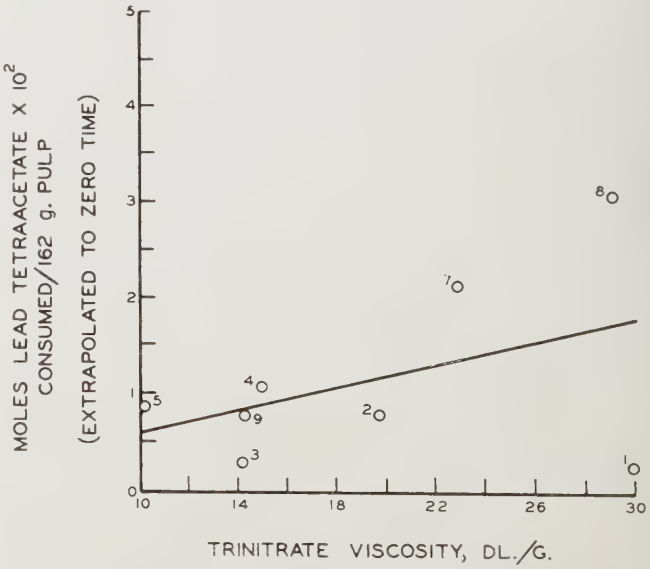


Fig. 6. Influence of trinitrate viscosity upon tetraacetate consumption

Numbers refer to pulps

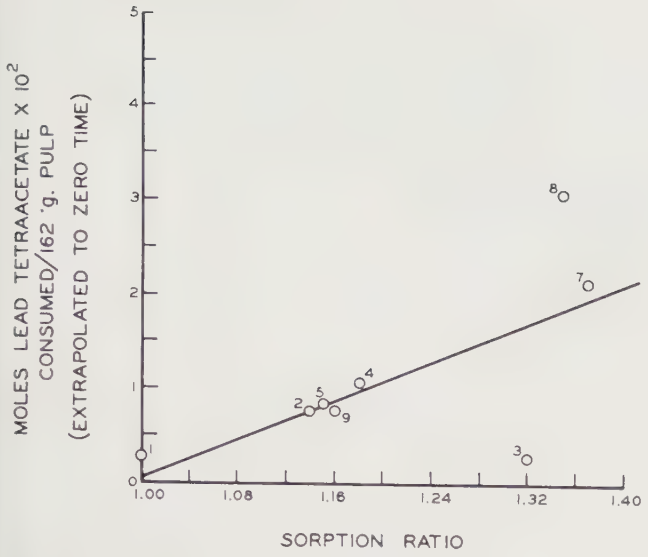


Fig. 7. Influence of sorption ratio upon tetraacetate consumption

Numbers refer to pulps

grams of sugar units removed per 100 g. of unoxidized pulp.

By comparing the grams of glucose and mannose units *present* in the unoxidized pulp per gram of xylose unit with the grams of glucose and mannose units *lost* per gram of xylose unit lost, Table V was prepared. (*Notice that the first group in Table V gives the ratios of sugars originally present in the unoxidized pulps, while the second group gives the ratios of the actual sugar removed.*)

Table IIIa. Sugar Units Composition of Selected Pulps

Pulp no.	Mean yield, %	Sugar	Percentage by weight, total determined sugars[a] Unoxidized, %	After 600 min. oxidn., %
4	86.0	Glucose	95.3	97.2
		Mannose	2.5	1.0
		Xylose	2.2	1.8
5	76.3	Glucose	96.1	98.0
		Mannose	2.5	0.9
		Xylose	1.4	1.1
9	90.9	Glucose	95.1	96.6
		Mannose	1.1	0.4
		Xylose	3.8	3.0

[a] Adjusted to 100%.

From Table V, it can be seen that the mannose unit removal is *greater* and the glucose unit removal is *less* than would be the case were the sugar units removed in the same ratio as that in which they exist in the unoxidized pulp. Thus, a preferential removal of mannose units is observed.

Table IIIb. Sugar Units Composition of Selected Pulps

Pulp no.	Mean yield, %	Sugar	Percentage by weight, total determined sugars[a] Unoxidized, %	After 65 min. oxidn., %	After 230 min. oxidn., %	After 600 or 625 min. oxidn., %
7	88.9	Glucose	87.9	..	94.0	92.0[b]
		Mannose	7.5	..	3.0	4.6
		Xylose	4.6	..	3.0	3.4
8	88.0	Glucose	83.5	88.9	89.2	90.6[c]
		Mannose	11.4	7.3	6.6	5.2
		Xylose	5.1	3.8	4.2	4.2

[a] Adjusted to 100%.
[b] Samples oxidized 600 min.
[c] Samples oxidized 625 min.

Table IV. Sugar Units Removal After 600 Minutes Oxidation[a]

Pulp no.	Percentage unoxidized sugar units removed — Glucose, %	Mannose, %	Xylose, %	Grams sugar units removed per 100 g. unoxidized pulp — Glucose, g.	Mannose, g.	Xylose, g.
4	12.4	64.0	27.3	11.8	1.6	0.6
5	22.2	72.0	42.8	21.3	1.8	0.6
7	6.9	45.4	34.8	6.1	3.4	1.6
8	4.6	59.6	27.5	3.8	6.8	1.4
9	7.7	63.6	29.0	7.3	0.7	1.1

[a] Pulp no. 8 oxidized 625 min.

IDENTIFICATION OF ERYTHROSE

A cellulosic material that is oxidized with lead tetraacetate or periodate should contain, in part, a structure consisting of erythrose and glyoxal units (*15*); consequently, hydrolysis of a glucose or mannose unit of an oxidized pulp should yield erythrose among the oxidation products.

A sample of oxidized pulp no. 8 was subjected to a *limited* hydrolysis by boiling with several quantities of 3% sulfuric acid. The combined hydrolyzates were neutralized, concentrated, and spotted on a chromatogram in conjunction with an authentic erythrose preparation [prepared by the method of Perlin and Brice (*16*)]. Upon development of the chromatogram with ethyl acetate:acetic acid:water (9:2:2, v/v) and spraying with a 2% solution of the phosphate salt of *o*-aminobiphenyl (*17*), an *erythrose* spot was observed.

Thus, the mechanism of the lead tetraacetate oxidation of cellulose must be similar to that of simple sugars; i.e., the 2,3-glycol grouping is cleaved to form the dialdehyde.

THE OXIDATION SOLUTION

Using oxidized pulp no. 8 as an example, the following data are available:

Yield, mean, % (see Table IIIb)	88.0
Yield, %, after 600 min. "control oxidation" in glacial acetic acid (no lead tetraacetate present)	95.8
Yield, %, after 600 min. oxidation. Tetraacetate removed by washing the pulp with acetic acid. Pulp dried from acetic acid. (*No water present*); occluded acid removed from dried oxidized pulp with ethanol and water to constant weight	94.3

It is postulated then, that the "standard" method of "stopping" an oxidation—that of adding an aqueous potassium iodide-sodium acetate solution and washing with water until the red iodine coloration is removed—has a drastic effect upon the pulp yield. Presumably, the water dilutes the acetic acid which then causes the hydrolysis or solution of portions of the partly oxidized pulp.

In order to support this postulate, the oxidation solution was investigated. Lead ions were removed by

Table V. Comparison of Ratio of Sugar Units Removed to Original Ratio

Pulp no.	Grams sugar units in unoxidized pulp per g. xylose unit — Glucose, g.	Mannose, g.	Xylose, g.	Grams sugar units lost per g. xylose unit lost — Glucose, g.	Mannose, g.	Xylose, g.
4	43.3	1.1	1.0	19.7	2.7	1.0
5	68.6	1.8	1.0	35.5	3.0	1.0
7	19.1	1.6	1.0	3.8	2.1	1.0
8	16.4	2.2	1.0	2.7	4.9	1.0
9	25.0	0.3	1.0	6.6	0.6	1.0

passing the solution through an IR-120 cation-exchange resin. The resin was washed until a negative Molisch test was obtained; the solution and washings were then concentrated and investigated chromatographically. Upon spraying of the developed chromatogram with a spray sensitive to reducing sugars (*o*-aminobiphenyl), a streaking was observed extending from the origin through the glucose spot (a mannose spot was also observed). Possibly, the streaking was due to partly oxidized oligosaccharide fragments.

DISCUSSION AND CONCLUSIONS

1. Mannose units are preferentially and partially removed from a pulp during the lead tetraacetate oxidation process (the loss ranges from 45 to 72% of the original mannose unit content, depending upon the pulp). This selective removal of mannose units is thus in agreement with the findings of Roudier and Nick (*13*).

2. The extent of the mannose unit loss is considerably greater than the range observed by Roudier and Nick (16 to 40%). The temperature of the oxidation (50°C., in contrast to 30°C., the temperature employed by these authors) is believed to be an important factor in accounting for this difference.

3. A lesser but significant removal of xylose units is found upon oxidation of a pulp (27 to 43%), again confirming the work of Roudier and Nick. A smaller amount of the original glucose units were lost (4 to 22%).

4. The removal or "loss" of sugar units during an oxidation is not attributable to oxidation alone; rather, the "mechanism" of the removal is probably an oxidation followed by a limited hydrolysis or solution of those sugar units in the more accessible, amorphous portions of the oxidized pulp. The determination of a lowered yield in the oxidized pulp and the presence of oxidized fragments in the oxidation solution, thus, in part, support this postulate.

5. That a 2,3-glycol oxidation of a hexose unit occurs is indicated by the chromatographic identification of erythrose in a hydrolyzate of the partly oxidized pulp.

6. The degree of polymerization has relatively little influence upon the extent of oxidation of a pulp with lead tetraacetate.

7. The importance of the accessibility of a pulp, as such, in influencing the extent of oxidation of the pulp with tetraacetate, is *secondary* to the mannose unit percentage of the pulp. The statistical correlation between the accessibility of a pulp and the tetraacetate consumption requires more study, however, partly because of the limited number of pulps used in this study, and partly because of the almost certain relationship (statistical interaction) between the variables—mannose, xylose, and sorption ratio.

A more detailed discussion of the factors contributing to the oxidation may be found in the thesis upon which the present paper is based (*18*).

EXPERIMENTAL

Lead Tetraacetate Oxidation of Pulps

Approximately 0.27 g. of pulp (dried 4 hr. at 105°C.) was transferred to a 500-ml. flask and placed in a 50°C. water bath of polyester composition. Stirring was accomplished by means of a magnetic stirrer.

The pulp was stirred for two hours in 50 ml. of glacial acetic acid (*of known weight*) in order to "activate" the pulp, and then 110 ml. of a preheated lead tetraacetate solution in acetic acid (*of known weight*) was transferred to the flask. The oxidation was allowed to proceed for a previously selected time and then a 25-ml. aliquot of the oxidation solution was removed from the flask, charged into a previously weighed 125-ml. Erlenmeyer flask, and weighed; 55 ml. of a buffered "stopping solution" (10 g. potassium iodide and 50 g. sodium acetate per 100 ml. water) were added, and the solution was titrated with 0.02 *N* sodium thiosulfate, dispensed from a weight-buret, using Thyodene as the indicator. To the pulp and solution remaining in the oxidation flask were added 290 ml. stopping solution. The oxidized pulp was washed with water, then with ethanol, and stored under ethanol.

The sodium thiosulfate solution had been previously standardized by weight or by volume and specific gravity. The lead tetraacetate solution was prepared so that the concentration ratio of tetraacetate to anhydroglucose would be 1/1 (mole/mole).

It should be noted that each pulp sample was used to obtain only one point on the oxidation curve; i.e., each point was determined independently of every other point.

Correction for Blank Decomposition

Similar "oxidations" as described above, run in the absence of pulp, yielded the values necessary for the plotting of a "blank-decay" curve. By subtraction of the blank-decay curve from the values obtained for the oxidation curve, the tetraacetate consumed by the pulp itself could be determined. These corrected values are used in the curves in Fig. 3.

LITERATURE CITED

1. Criegee, R., *Ber.* 64: 260–266 (1931).
2. Criegee, R., *Ber.* 65: 1770–1772 (1931).
3. Criegee, R., *Ann.* 495: 211–225 (1932).
4. Hockett, R. C. and McClenahan, W. S., *J. Am. Chem. Soc.* 60: 2061–2063 (Sept., 1939).
5. Hockett, R. C. and McClenahan, W. S., *J. Am. Chem. Soc.* 61: 1667–1671 (July, 1939).
6. Hockett, R. C., Dienes, M. T., and Ramsden, H. E., *J. Am. Chem. Soc.* 65: 1474–1477 (Aug., 1943).
7. Hockett, R. C., Dienes, M. T., and Fletcher, H. G., Jr., *J. Am. Chem. Soc.* 66: 467–468 (March, 1944).
8. Hockett, R. C., Nickerson, M. H., and Reeder, W. H., *J. Am. Chem. Soc.* 66: 472–474 (March, 1944).
9. Hockett, R. C. and Zief, M., *J. Am. Chem. Soc.* 72: 2130–2132 (May, 1950).
10. Perlin, A. S. and Lansdown, A. R., *Can. J. Chem.* 34: 451–455 (1956).
11. Steinmann, H. W. and White, B. B., *Tappi* 37: 225–232 (1954).
12. Matsuzaki, K. and Ward, K., Jr., *Tappi* 42: 516–518 (1959).
13. Roudier, A. and Nick, D., *Mem. Serv. Chim. Etat.* (*Paris*) 41: 181–190 (1957).
14. Detrick, R. W., Submitted for publication in *Tappi*.
15. Jackson, E. L., and Hudson, C. S., *J. Am. Chem. Soc.*, 60: 989–991 (May, 1938).
16. Perlin, A. S. and Brice, C., *Can. J. Chem.* 33: 1216 (1955).
17. Rapson, W. H. and Morbey, G. K., *Tappi* 42: 125–130 (1959).
18. Detrick, R. W., "The Oxidation of Pulps with Lead Tetraacetate," Doctor's Dissertation, Appleton, Wis., The Institute of Paper Chemistry, 1960, 90 p.

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

A portion of a thesis submitted in partial fulfillment of the requirements of The Institute of Paper Chemistry for the degree of Doctor of Philosophy from Lawrence College, Appleton, Wis., June, 1960. This work was carried out under the direction of Kyle Ward, Jr.

The guidance and advice so freely given by the author's thesis committee—Kyle Ward, Jr., John W. Green, B. L. Browning, and Harold Swenson—are greatly appreciated.

High Wet-Strength Paper by Wet-End Addition of Dialdehyde Starch

B. T. HOFREITER, G. E. HAMERSTRAND, C. L. MEHLTRETTER, W. E. SCHULZE, and A. J. ERNST

Dialdehyde starch, a polymeric dialdehyde produced by periodic acid oxidation of cornstarch, has recently been shown to produce wet-strength in paper when applied as a tub size. Usefulness of this new wet-strength agent is extended by establishment of conditions for wet-end addition. Excellent wet strength and improved dry-strength properties result from 0.5 to 10% application based on the dry pulp. The manner of dispersion of the dialdehyde starch, use of alum, and pH were found to be determinate factors in the retention of dialdehyde starch by the cellulosic fibers. Advantages of the wet-end addition of dialdehyde starch in papermaking are: rapid development of wet strength without heat, no extended cure required for either the stable dialdehyde dispersions or the newly formed sheets, ease of broke recovery, and commercial availability of this product.

THE increased use of specialty papers having high wet strength has developed chiefly because of the introduction of melamine- and urea-formaldehyde resins. During the past decade efforts have been directed not only toward the improvement of such resins, but also toward the synthesis of new products with even more attractive properties for producing wet strength in paper. This study reports the application of dialdehyde starch (DAS) (*1–3*) by wet-end addition which results in papers possessing excellent wet strength and improved dry strength.

The introduction of carbonyl groups into paper by periodate oxidation of pulp was demonstrated earlier (*4*) to produce wet strength. More recently Meller (*5*) showed that periodate oxidized wheat starch, when used as a beater additive to eucalyptus sulfate pulp, produces a measure of wet strength in paper. The strength values reported were low and were obtained with DAS applications at 5 to 10% levels of the fiber weight. Concurrently, Jones, *et al.* (*6*), examined the utility of DAS as a tub-sizing agent and were able to prepare papers having excellent wet strength and improved dry strength. The earlier work sufficiently established the wet-strengthening properties of DAS, and it remained only to develop practical conditions under which DAS would be retained by the cellulosic fibers prior to sheet formation. Promising results were obtained by wet-end addition through investigation of such factors as the concentration of alum and DAS, presence of bicarbonate, the pH of the pulp slurry, and manner of dispersion of DAS. Additives other than alum that materially assist the retention of DAS are now under investigation.

B. T. HOFREITER, G. E. HAMERSTRAND, C. L. MEHLTRETTER, W. E. SCHULZE, and A. J. ERNST, Northern Regional Research Laboratory, Peoria, Ill. This is a laboratory of the Northern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

MATERIALS AND METHODS

Western bleached sulfite (*7*), and both unbleached and bleached softwood sulfate pulps were employed for comparative purposes. The bleached softwood sulfate pulp (700 ml. S.-R.) was used to establish optimum conditions for development of wet strength by DAS. Handsheets were made with furnishes containing these pulps according to TAPPI Standards.

Dialdehyde starch was prepared by periodic acid oxidation of commercial unmodified pearl cornstarch to the extent of 96% of theory and thus contained 96 dialdehyde units per 100 repeating units of the polymer (*1*). Starches other than corn, however, may also be used for this purpose. The polymeric dialdehyde prepared from cornstarch is now in commercial production (*3*).

For laboratory experiments, the DAS was dispersed in water in 3% concentration in the presence of sodium bisulfite by cooking in a Corn Industries Research Foundation viscometer (CIRF) at a bath temperature of 92°C. This viscometer continuously records viscosity changes with time of cooking and insures uniform dispersion for various preparations. Figure 1 illustrates the change in viscosity with time of heating and also shows the variations produced by different concentrations of sodium bisulfite.

Tap water used in preparing handsheets had a hard-

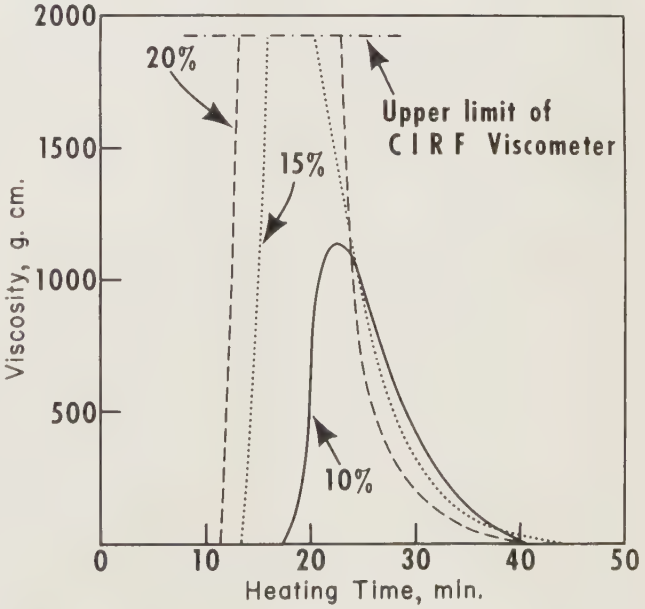


Fig. 1. Corn Industries Research Foundation viscometer curves for dialdehyde starch at 3% concentration employing 10, 15, and 20% $NaHSO_3$ based on the weight of dialdehyde starch

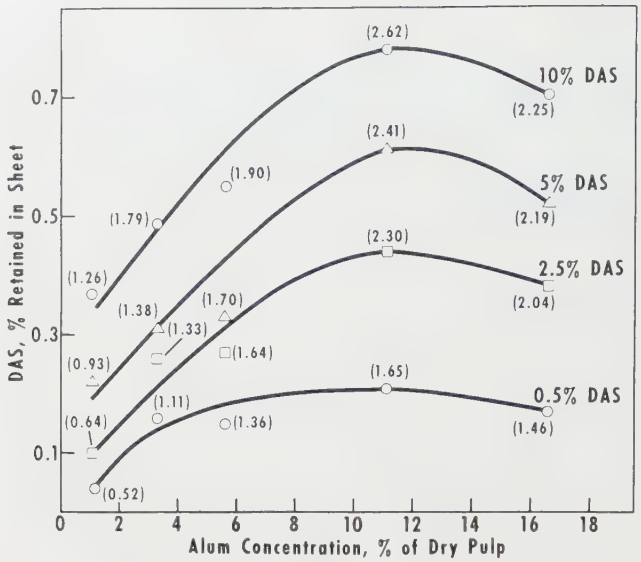


Fig. 2. Variation of dialdehyde starch retention with alum concentration for levels of dialdehyde starch application over the range 0.5 to 10% (% of dry pulp). Breaking length (km.) in parentheses

ness of 344 p.p.m. (calculated as calcium carbonate) and an alkalinity of 142 p.p.m.

Handsheets were made from pulp slurries having a consistency of 0.375%. In most instances the pH of these slurries was adjusted to 6.0 with hydrochloric acid. When appropriate quantities of 0.02 *M* $Al_2(SO_4)_3 \cdot 18H_2O$ solution were added and the slurry was stirred for 2 min. the pH was lowered to approximately 4.5. Solutions of the dispersed DAS (0.6% concentration) were then added with no change in pH, and the pulp slurries were stirred for an additional 2 min. before sheet formation. Water used in the sheet mold for dilution was adjusted to pH 4.5 prior to mixing with the pulp slurry. Handsheets (1.2 g. dry fiber) were formed on a British Sheet Machine (200 sq. cm.) and then wet pressed and conditioned for at least 24 hr. before physical testing.

Maximum increases of wet strength were obtained when alum was introduced to the stock prior to DAS addition. Handsheets prepared from a furnish to which a mixture of alum and DAS has been added as a single solution had relatively low wet strengths.

Retention of DAS was determined through minor modification of a semimicro method for DAS developed at the Northern Laboratory (*8*). Weighed pieces of the papers of known moisture content were heated in an acetic acid solution of *p*-nitrophenylhydrazine to react with the retained DAS. Excess *p*-nitrophenylhydrazine was washed from the paper and the hydrazones were extracted with methyl cellosolve. Concentration of the extracts was determined colorimetrically in a spectrophotometer.

Development of Wet Strength

The development of wet strength in paper by the application of additives to the stock at the wet end of the paper machine requires adequate retention of the wet-strength agent in the fiber and the final sheet. Alum is commonly used to increase retention of certain wet-strength resins and its behavior is sometimes affected by the presence of bicarbonates in the water supply. Accordingly alum and bicarbonate additions were first investigated as retention aids for DAS.

Alum. Handsheets were prepared as described using varying quantities of aluminum sulfate and tap water. When alum concentrations of 5 to 6% (weight basis of dry pulp) or less were used, the final pH was above 4.5 and acid was added to adjust to 4.5 before DAS addition. Both DAS retention and wet breaking length were determined (Fig. 2).

At all levels of application DAS retention by the fiber is increased when alum is used (Fig. 2); the maximum is reached at an alum concentration near 11%. The breaking lengths of the handsheets in kilometers are also given in Fig. 2 for each of the points from which the curves are derived.

Figures 3 and 4 (using the same data as in Fig. 2) show the variation of DAS retention and wet strength in the handsheets with the level of DAS application. Although the increases in DAS retention are about in direct proportion to the quantities applied, the rate of wet-strength development decreases markedly following a rapid initial rise.

Effects of Bicarbonate. Studies were made of the effect of the extremely hard local tap water on the wet strengthening process. Handsheets made with tap water, bicarbonate solution, and distilled water were compared for DAS retention and wet-strength properties. Table I shows that the highest degree of wet strength was obtained with the sodium bicarbonate solution.

pH. The retention of DAS on cellulose fibers and the development of wet strength are both affected by pH. Data shown in Fig. 5 were obtained from handsheets made by using a 2.5% level of DAS and 11.1% alum. After adding alum to pulp slurries previously adjusted to various pH levels with hydrochloric acid, the pH value was obtained. Diluent water used to

Table I. Effects of Water Source on Dialdehyde Starch Treatment

Preparative conditions				*Handsheet properties*			
Application, basis of dry fiber DAS, %	Alum, %	*Sodium bicarbonate, p.p.m.*	*pH*[a]	*DAS retained, basis of dry sheet, wt., %*	*Breaking length* Dry, km.	Wet,[b] km.	*Wet tensile* × 100 / *Dry tensile, %*
0	0	0	6.2	0	8.6	0.22	2.6
5	0	0	6.2	0.16	8.8	0.86	9.8
5	0	0	4.5	0.16	8.8	0.98	11.1
5	0	344[c]	4.8	0.68	8.5	0.93	11.0
5	11.1	0	4.0	0.39	9.2	1.45	15.8
5	11.1	344[c]	4.2	0.57	10.1	2.54	25.1
5	11.1	147	4.2	0.86	10.3	2.60	25.2
5	11.1	294	4.3	1.04	10.0	3.03	30.3
5	11.1	441	4.3	1.15	9.8	2.90	29.6
5	11.1	441	4.2	1.17	10.0	2.81	28.1

[a] In the concentrated pulp slurry (0.35% consistency).
[b] After immersion in distilled water at 23°C. for 30 min.
[c] Tap water—value is that of calculated calcium bicarbonate.

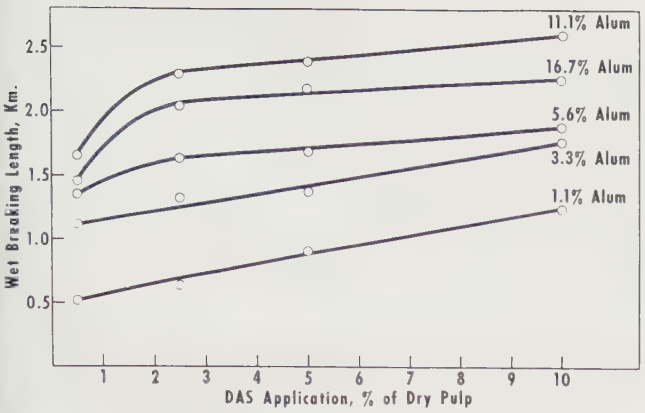


Fig. 3. Relationship of wet tensile strength to level of dialdehyde starch application as affected by alum concentration

form handsheets in the mold was preadjusted to this pH.

Retention of DAS at the various pH values is also plotted in Fig. 5. At pH above 4.5 the degree of retention does not diminish greatly; however, the wet strength decreases greatly. Below pH of 4.5 a close correlation exists between the variation of DAS retained and the wet strength developed. A possible explanation is that less cross-linking occurs at high pH by reaction of DAS carbonyl groups with the hydroxyl groups of cellulose.

Retention and Wet-Strength Relationships

As shown in Figs. 2 and 5 retention and wet strength are not directly interdependent. The relationship is complicated by such factors as the amount of alum present, DAS granules, and pH. Figure 6 was prepared to illustrate this using the data given in Fig. 2.

In Fig. 6, where all values for retention and wet strength obtained from several alum concentrations and DAS levels of application are plotted, there would appear to be no simple correlation of the data. However, lines drawn through points derived from a given concentration of alum are significant. For a given concentration of alum there is a regular relationship existing between percentage retention and degree of wet strength. The dotted line on the graph represents

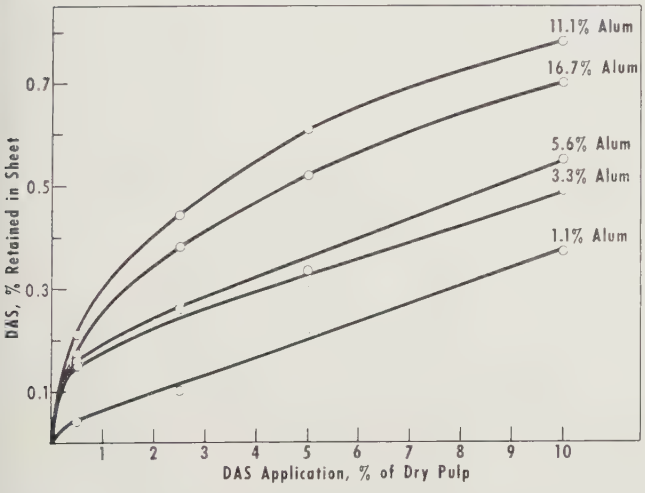


Fig. 4. Relationship of the level of dialdehyde starch application with dialdehyde starch retention as affected by alum concentration

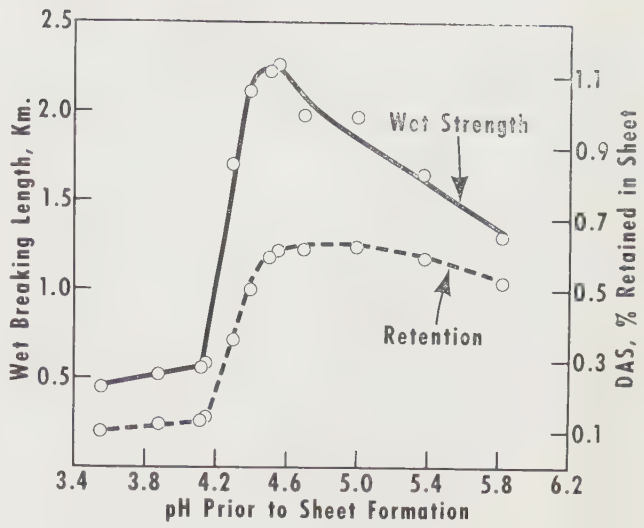


Fig. 5. Effect of pH of the pulp, prior to sheet formation on dialdehyde starch retention and wet strength

the ideal relationship for obtaining maximum efficiency of wet-strength development at any level of retention. From 0.2 to 0.8% retention this line exclusively follows points derived at an alum concentration of 11.1%.

Permanency of Wet Strength. The loss of wet strength by test strips immersed in distilled water (pH ca. 5.5) at 23°C. is shown in Table II. Although the wet strength declines, the degree of permanence is sufficient for most applications and, in addition, allows for convenient recovery of broke.

Dialdehyde Starch Dispersions

Aqueous DAS slurries at neutral or acid pH are difficult to disperse in water by application of heat alone. The well-known alkali sensitivity of DAS precludes the alternate use of alkali, particularly if molecular size is of significance in obtaining retention of DAS in the fiber for the development of wet strength.

Dependence of DAS retention and wet-strength development in paper on the concentration of sodium bisulfite and on the extent of cooking of the dispersions was investigated. Three DAS dispersions (3% concentration) were prepared by heating at 92°C. in the CIRF viscometer with 10, 15, and 20% sodium bisul-

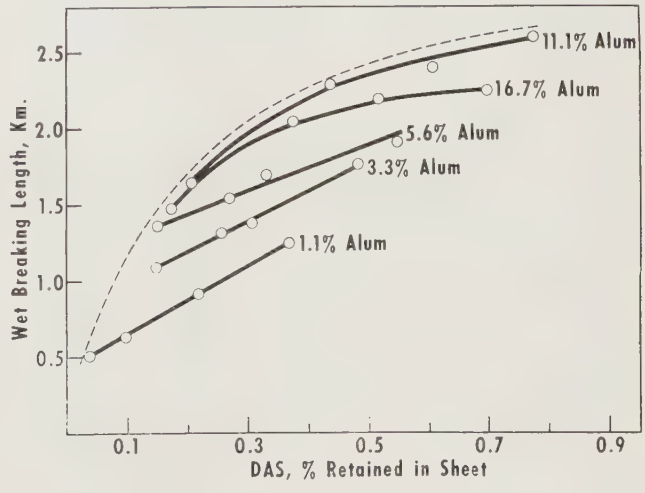


Fig. 6. Effects of alum concentration on the relationship between wet tensile strength and dialdehyde starch retention

Table II. Permanency of Wet Strength

Immersion time,[a] min.	*Breaking length, km.*	*Wet tensile × 100, / Dry tensile, %*
0.5	2.50	27.5
5	2.25	24.8
15	2.16	23.8
30	2.00	22.0
60	1.79	19.7
90	1.73	19.0

[a] In distilled water of pH 5.5 at 23°C.
[b] DAS-treated paper.

fite (DAS weight basis). As pasting progressed (Fig. 1) samples were withdrawn, immediately cooled, and used at 0.5, 2.5, and 5.0% levels of DAS application to prepare handsheets. Wet tensile strength and DAS retention of the handsheets were measured.

Figure 7 illustrates the effect of heating time at 92°C. of a 3% aqueous DAS dispersion containing 15% bisulfite (DAS weight basis) on wet strength and DAS retention in handsheets prepared at a 5% DAS application (dry fiber weight basis). During the first 20 to 30 min. of heating, when the viscosity of the dispersion is extremely high because of swollen DAS granules, DAS retention appears to be mainly through mechanical entanglement in the cellulosic fibers. Microscopic examination of the dispersions, after heating for 40 min. at 92°C., revealed the presence of only a few whole granules. Pickup of DAS by the fibers from such granule-free dispersions apparently is a function of molecular size of the polymeric dialdehydes

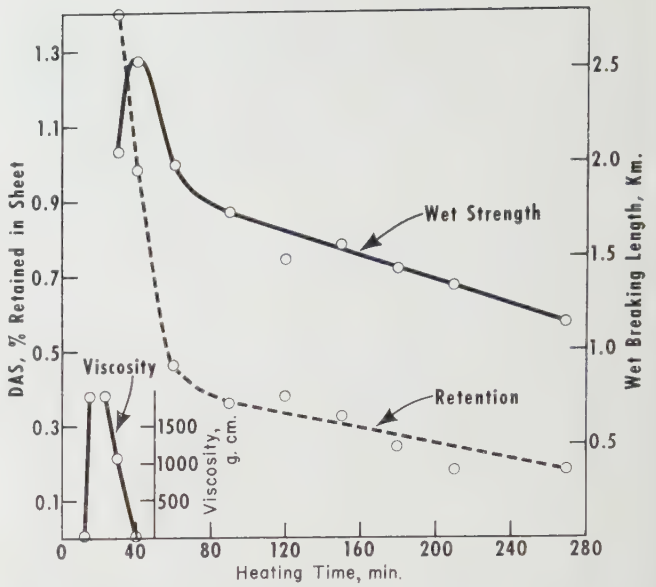


Fig. 7. Relation of heating time at 92°C. of 3% dialdehyde starch dispersions containing 15% $NaHSO_3$ (dialdehyde starch weight basis) on the retention and wet strength of paper at 5% level of dialdehyde starch application

Drying

Normally handsheets were dried and conditioned according to TAPPI Standards. To determine the effect of drying at elevated temperatures on the wet-strength properties of the sheet, the following experiment was performed: handsheets containing DAS were prepared in the usual manner and half of them were conditioned at 23°C. and 50% R.H. The remainder, immediately after wet pressing, were heated in an oven at both 100 and 150°C. for 1, 5, and 15 min. Half of the conditioned sheets were then heated the same way prior to testing dry and wet tensile strengths. No significant differences were found in wet-strength properties as a result of the various drying treatments.

Table III. Effect of Dialdehyde Starch Treatment on Several Pulp Types

Pulp[a]	*DAS retained, basis of dry sheet wt., %*	*Breaking length — Control — Dry, km.*	*Breaking length — Control — Wet, km.*	*Breaking length — Treated — Dry, km.*	*Breaking length — Treated — Wet, km.*	*Wet tensile × 100, / Dry tensile, %*	*Dry strength increase, %*
Bleached softwood sulfate	0.57	8.4	0.27	9.8	2.46	25.1	16.7
Unbleached softwood sulfate[b]	0.42	7.5	0.20	9.4	2.35	25.0	25.3
Western bleached sulfite[c]	0.43	5.2	0.19	6.3	1.18	18.7	21.2

[a] Handsheets were prepared with tap water using 2.5% DAS application, 11.1% alum, and a pH of 4.5.
[b] 740 ml. S.-R.
[c] 585 ml. S.-R.

formed by hydrolytic degradation. A regular decline of retention and wet strength occurs when times of dispersion are greater than 40 min. Variation in bisulfite concentration within the levels investigated does not significantly alter the wet strength-dispersion time pattern.

Table IV. General Physical Properties of Paper Containing Dialdehyde Starch

Test	*Control*	*DAS-treated[a]*	*Change, %*
Basis weight (25 × 40 −500)	48.8	48.8	...
Burst, points	65	81	+24.6
Tear factor	139	113	−18.7
Breaking length, km.			
Dry	8.4	9.8	+16.7
Wet, 30 min.	0.27	2.46	+810
Schopper fold	1380	1460	+5.8
Porosity, sec./100 cc.	120	148	+23.4
Water absorption—Cobb, g./sq. m. −min.	96	64	−33
Brightness (Hunter), %	78	71	−9.0
DAS retained on fiber, %	...	0.57	...

[a] Using 2.5% level of DAS application, 11.1% alum, and pH 4.5 in tap water.

Pulp

The responsiveness of three types of cellulose pulp to DAS treatment for wet- and dry-strength production is summarized in Table III. No significant differences were found.

General Physical Properties of Handsheets Containing Dialdehyde Starch

A series of handsheets using DAS at 2.5% level of application was prepared and evaluated for a number of physical properties (Table IV).

Of primary importance is the development of wet strength, which is 25% of the dry tensile strength of the treated sheet after immersion at 23°C. for 30 min. Also of significance are the increases obtained in dry

strength. Dry tensile and dry burst strengths were increased 16.7 and 24.6%, respectively. A very slight increase of 5.8% was observed for the Schopper fold. However, those properties which are ordinarily adversely affected by wet-strength resins are also so affected by DAS. Dry tear strength, porosity, water absorbency, and brightness are properties diminished by DAS.

SUMMARY AND CONCLUSIONS

The principal objective has been to define some conditions under which dialdehyde starch (DAS) could be used efficiently as a beater or wet-end additive to produce wet strength in paper. Maximum effective retention of DAS by cellulose fibers is dependent upon several factors: (1) DAS granules must be dispersed through hydration under conditions that result in controlled depolymerization; (2) aluminum ion must be present in both proper quantity and complex form; the aluminum-complex ion form is governed by both the pH and the presence of other ions, such as bicarbonate; the relationship existing between DAS retention and wet strength developed is shown to be modified by alum concentration, pH, and relative amounts of whole granules.

The pH conditions under which maximum retention is obtained are above pH 4.4 and are similar to those required in many pulp-resin systems. Development of maximum wet strength in papers containing DAS is best at pH 4.5. The wet-strength mechanism possibly involves cross-linking of the cellulose fibers through acetal formation.

Desirable features found to be associated with the use of DAS in papermaking are:

1. Rapid development of wet strength in the sheet with no extended cure or additional heating required.
2. Simplicity of preparing DAS dispersions.
3. Stability on storage of DAS.
4. Substantial improvement in dry tensile and burst strengths.
5. Ease of broke recovery.
6. Availability from an unlimited raw material source (*3*).

LITERATURE CITED

1. Mehltretter, C. L., Rankin, J. C., and Watson, P. R., *Ind. Eng. Chem.* 49: 350–354 (1957).
2. Sloan, J. W., Hofreiter, B. T., Mellies, R. L., and Wolff, I. A., *Ind. Eng. Chem.* 48: 1165–1172 (1956).
3. Anonymous, *Chem. Eng. News* 37, No. 50: 28–29 (1959).
4. Schur, M. O. and Levy, R. M., *Tech. Assoc. Papers* 30: 203–206 (1947).
5. Meller, A., *Tappi* 41, No. 11: 679–683 (1958).
6. Jones, J. E., Wabers, Bette, Swanson, J. W., Mehltretter, C. L., and Senti, F. R., *Tappi* 24, No. 18: 862–866 (1959).
7. Winchester, A. J., *Tappi* 41, No. 12: 173A–178A (1958).
8. Wise, C. S. and Mehltretter, C. L., *Anal. Chem.* 30: 174–175 (1958).

Received May 10, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

The authors gratefully acknowledge the assistance rendered by D. E. Smith and L. E. Talley in some of the physical testings reported.

Sweetgum Sulfate and Neutral Sulfite Semichemical Pulps for Linerboard

D. J. FAHEY and V. C. SETTERHOLM

Linerboards, equivalent to commercial southern kraft boards, were made from mixtures of 25% of either sweetgum neutral sulfite semichemical (75% yield), or sweetgum sulfate (48% yield) pulp, and 75% southern pine sulfate pulp. Tearing strength and folding endurance were adversely affected with higher percentages of either of the sweetgum pulps. The bursting strength was maintained when the sweetgum sulfate pulp was substituted for the pine kraft, but it was lowered somewhat when neutral sulfite semichemical pulp was used. To develop the bursting strength needed, it was necessary to lower the freeness of the neutral sulfite semichemical pulp considerably below that for the sweetgum sulfate pulp when large amounts of hardwood were used. The addition of either of the gum pulps improved the ring compression strength of the liners. This would proportionately increase the top-to-bottom compressive strength of boxes. Resistance to rough handling, determined by drop tests on boxes with liners containing various percentages of the gum neutral sulfite pulp, was adversely affected by the addition of the hardwood pulp. Where stacking resistance in the boxes is more important than impact resistance, the addition of gum pulps to linerboard furnishes is beneficial. Newly devised test methods for determining compression and tensile properties were utilized in the evaluation of linerboards containing sweetgum neutral sulfite semichemical pulp. Changes in modulus of elasticity resulting from changes in hardwood content corresponded with the measured changes in bending stiffness of the combined boards.

Linerboard, which is made almost entirely from softwood, constitutes the largest tonnage of any paperboard product manufactured in the south today. Fiber boxes made from southern pine kraft pulp have set high standards for strength and toughness in the container industry. The great demand for pine pulpwood has caused concern over our future supplies, particularly when hardwoods tend to replace the softwoods after cutting. In view of the extent to which our national forest economy is being affected by the tremendous growth of hardwoods, any effort that increases the utilization of the hardwoods is likely to be beneficial to timber stand management. The addition of even a small portion of these hardwoods in a high-tonnage product like linerboard could result in the use of a substantial amount.

Research, conducted at the Forest Products Laboratory over a number of years, has demonstrated the possibility of pulping hardwoods by several processes for use in various paper products. Northern hard-

D. J. Fahey, Technologist, and V. C. Setterholm, Technologist, Forest Service, U. S. Department of Agriculture, Forest Products Laboratory, Madison, Wis.

wood pulps have been used experimentally in the manufacture of linerboard. Boards meeting commercial specifications and use requirements were produced from mixtures of aspen semichemical and jack pine semichemical pulps (*1*). Heretofore much of the experimental work on southern hardwoods for linerboard has been concerned with using large percentages of the pulp in the furnish and attempting to meet the burst requirement of the test liner by making boards of heavy weight.

This report is concerned with experiments on sweetgum pulped by both the neutral sulfite semichemical process and the sulfate process. Good compression resistance is inherent in liners and corrugating boards made from hardwood neutral sulfite pulps, and for this reason, these pulps now dominate the corrugating board field. Such pulps should be beneficial ingredients in liners by providing boxes with more rigidity.

From the early work reported by Carlson (*2*) and the more recent work by Kellicutt and Landt (*3*), it can be shown that, on a weight basis, the liners contribute more to box compression strength than does the corrugating medium. Because of the ability of hardwood semichemical pulp to improve compression strength, it seemed that the addition of at least a portion of the pulp to the furnish of linerboard would improve the compressive strength of the box.

MATERIALS

Wood

The sweetgum wood (*Liquidambar styraciflua*) used in this study came from near Asheville, N. C. It had an average specific gravity of 0.495, based on weight when airdry and on volume when green, and a density of 30.9 lb. per cu. ft. Its average age was 29 years. For the pulping experiments, the wood was received bark free and converted into standard $^5/_8$-in. chips.

Pulps

Sweetgum Neutral Sulfite Semichemical Pulp.—The sweetgum neutral sulfite semichemical pulp was made in an indirectly heated stainless-steel-lined digester with a capacity of 225 cu. ft. The digestion (No. 1-5624N) was conducted as follows: The chips were pre-steamed at atmospheric pressure for 30 min. before the pulping liquor, with a concentration of 35.3 g.p.l. of sodium sulfite and 16.0 g.p.l. of sodium carbonate, was pumped in. The digester contents were heated to 170°C. in $2^1/_2$ hr., and this temperature was maintained for 1 hr. The liquor at the end of the cook had a residual of approximately 12.8 g.p.l. of sodium sulfite and a pH of 7.0. After cooking, the chips were drained and then fiberized in a commercial-size 36-inch double-disk refiner. A pulp yield of about 75% was obtained. The majority of the chips were refined to a Canadian Standard freeness of 590 ml., which gave a pulp free of shives. This freeness is comparable to that of southern pine kraft pulp currently used for making linerboard. To develop more bursting strength in the pulp, quantities were also refined to two lower freenesses, 475 and 410 ml. The three pulps were used in linerboard runs.

Sweetgum Sulfate Pulp.—This pulp (digestion No. 1-4243) was prepared in the same digester as the neutral sulfite pulp. For each 100 lb. of moisture-free wood cooked, 15 lb. of sodium hydroxide and 5 lb. of sodium sulfide were used. These chemicals, expressed as sodium oxide, were equal to an active alkali of 15.6 lb. per 100 lb. of moisture-free wood. The liquor-to-wood ratio was 4:1. The cooking liquor had a sulfidity (based on active alkali) of 25.5%. The temperature rise to 170°C. was $1^3/_4$ hr., and this temperature then was maintained for $1^1/_2$ hr. before blowing. The yield of screened pulp was about 48%.

Commercial Southern Pine Sulfate Pulp.—A quantity of airdried commercial southern pine sulfate pulp of linerboard grade was obtained for blending with the experimental sweetgum pulps.

Table I.—Strength Data for Unbleached Sulfate and Neutral Sulfite Semichemical Pulps[a]

Beating time, min	*Freeness (Canadian Standard), ml.*	*Burst factor*	*Tear factor*	*Folding endurance (MIT), double folds*	*Breaking length, m.*	*Density, g./cc.*
Sweetgum Sulfate Pulp (Digestion No. 1-4243)						
0	705	8	45	2	1355	0.35
10	600	35	127	71	7570	0.52
20	360	64	97	604	9820	0.70
25	240	65	91	944	10,500	0.73
17	450	57	107	325	9,140	0.65
25	250	65	91	920	10,480	0.73
Sweetgum Neutral Sulfite Semichemical Pulp (Digestion No. 1-5624N)						
0	560	12	77	3	3200	0.41
10	440	19	94	8	4160	0.46
20	330	26	96	25	4890	0.52
30	225	35	81	66	8900	0.58
10	450	18	93	7	4100	0.45
27	250	33	86	52	6560	0.56
Commercial Unbleached Southern Pine Sulfate Pulp (Shipment No. 4372)						
0	740	12	150	3	2170	0.42
15	665	33	214	160	5500	0.53
30	520	50	157	390	7630	0.59
45	300	59	139	594	9500	0.63
50	230	59	128	703	9580	0.64
36	450	56	151	400	8560	0.61
48	250	59	130	690	9560	0.64

[a] Data obtained on handsheets weighing approximately 72.4 g. per sq. m. (moisture-free). Values at freenesses of 450 and 250 ml. are interpolated.

Properties of the Pulps

The strength properties, as determined by a beater test evaluation obtained on the pulps used in this study, are given in Table I. Except for tearing strength, the gum sulfate pulp proved stronger than the gum neutral sulfite pulp.

LINERBOARD EXPERIMENTS

Linerboards weighing 42 lb. per 1000 sq. ft. were made on the experimental fourdrinier paper machine from blends of (1) gum sulfate and pine sulfate pulps, and (2) gum neutral sulfite and pine sulfate pulps. In both series, the hardwood pulp in the several furnishes amounted to 15, 25, 50, 75, and 100%.

The quality of the boards was judged by direct comparison with the average properties obtained on three commercial kraft liners made from southern pine, an all-pine board made experimentally, and the test liner specification of the National Paperboard Association. The test liner specification requires that a 42-lb.

Table II.—Properties of Linerboards Made from Sweetgun and Southern Pine Pulps

Machine run no.	Fiber furnish: Southern pine sulfate, %	Fiber furnish: Sweetgum pulp Kind	Fiber furnish: Sweetgum pulp Amount, %	Headbox freeness (Canadian Standard), ml.	Weight: Ream,[a] lb.	Weight: 1000 sq.ft., lb.	Thickness, mils.	Density, g./cc.	Bursting strength: Pts.	Bursting strength: Pts./lb./rm.	Average tearing resistance, grams	Average tensile strength, lb./in. width	Average folding endurance (MIT), double folds	Ring compression: Machine direction, lb.	Ring compression: Cross-machine direction, lb.	Air resistance (Gurley), sec. per 100 cc.	Brightness (G.E. equivalent), %
Average for 3 Commercial Boards																	
...	..	.	..	.	146.9	42.3	12.5	0.65	116.1	0.79	363	66.2	968	116.9	86.3	..	...
Board Made Experimentally from (Commercial) Southern Pine Sulfate Pulp																	
4969	100	...	..	575	144.0	41.5	11.0	0.72	104.1	0.73	369	63.2	890	101.0	68.0	16	23.1
Boards Made from Pine Sulfate and Gum Sulfate Pulps																	
5179	85	Sulfate	15	565	146.8	42.2	11.4	0.71	126.6	0.87	333	67.4	754	111.6	78.9	..	...
5177	75	Sulfate	25	570	146.0	42.0	11.2	0.72	116.5	0.81	319	65.3	520	105.8	76.4	.	...
5175	50	Sulfate	50	550	150.8	43.4	11.6	0.72	122.9	0.81	280	72.2	543	115.1	86.3	..	...
5176	25	Sulfate	75	565	146.0	42.0	11.1	0.72	119.7	0.81	282	71.3	459	114.9	82.3	..	...
5178	..	Sulfate	100	540	149.4	43.0	11.5	0.72	121.9	0.81	202	75.5	344	120.0	90.1	..	...
Boards Made from Pine Sulfate and Gum NSSC[b] Pulps (Milled to a Canadian Standard freeness of 590 ml.)																	
4974	85	NSSC	15	565	146.0	42.0	11.3	0.71	109.4	0.77	362	67.4	865	108.1	79.8	19	23.8
4973	75	NSSC	25	560	146.8	42.2	11.8	0.69	106.8	0.73	314	66.1	528	111.3	80.5	17	26.0
4970	50	NSSC	50	525	147.0	42.3	12.3	0.66	93.4	0.64	277	61.8	258	117.0	92.8	17	29.3
4971	25	NSSC	75	550	146.4	42.1	12.5	0.65	80.8	0.56	210	59.5	108	115.4	91.0	13	34.4
4972	..	NSSC	100	555	144.8	41.7	13.0	0.62	68.8	0.48	138	53.6	36	112.1	86.4	11	40.1
Boards Made from Pine Sulfate and Gum NSSC Pulps (Milled to a Canadian Standard freeness of 475 ml.)																	
4976	50	NSSC	50	515	147.4	42.4	11.4	0.71	107.4	0.74	282	71.5	380	131.4	93.1	27	28.8
4975	..	NSSC	100	465	146.0	42.0	12.2	0.66	86.2	0.60	153	63.9	90	138.1	102.8	27	40.4
Boards Made from Pine Sulfate and Gum NSSC Pulps (Milled to a Canadian Standard freeness of 410 ml.)																	
5000	25	NSSC	75	445	146.2	42.0	11.7	0.69	102.7	0.71	233	65.7	209	128.6	96.5	37	38.6
4999	..	NSSC	100	415	145.6	41.9	12.0	0.67	94.4	0.65	175	65.6	70	140.2	107.9	33	33.0

[a] 500 sheets, 25 by 40 in.
[b] Neutral sulfite semichemical.

weight board of the best grade have a minimum burst test of 100 points.

Boards Containing Gum Sulfate Pulp

A series of linerboards was made to show the effect on board properties of the addition of gum sulfate pulp to a pine sulfate pulp furnish. The pulps were processed separately in the beater to a Canadian Standard freeness of 575 ml. and then blended for the board runs. The results, as presented in Table II, disclose that the bursting strengths of all the gum-pine boards were the same, regardless of the amount of hardwood pulp they contained, and that all boards, including the board made with 100% gum sulfate, had bursting strengths greater than 100 points. Thus, all boards would meet this specification of test liners. The edgewise compressive strength was changed slightly by the gum sulfate pulp. It increased with increasing amounts of this pulp in the furnish. As the gum content of the board increased, better surface characteristics and formation resulted. With these improvements, the boards would be expected to provide a better printing surface.

Gum additions of up to 25% resulted in only a slight loss in tearing strength, but with larger percentages of the short-fiber pulp, this property decreased in proportion to the amount of gum pulp added. Although these high-gum-content boards were somewhat lower in tearing strength than the all-pine kraft liner, they may have sufficient strength for some boxes, since it

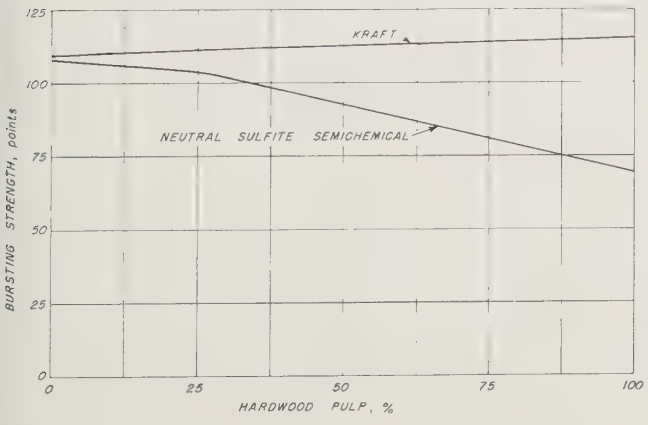


Fig. 1. Effect of hardwood content on bursting strength of linerboards made from pine kraft pulp and sweetgum kraft or neutral sulfite semichemical pulps

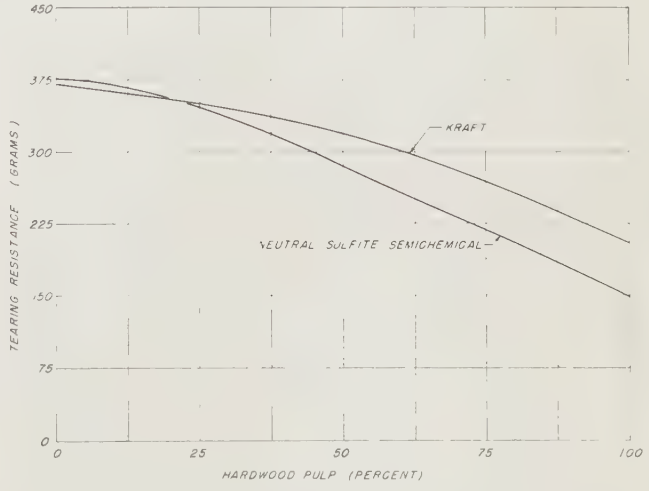


Fig. 2. Effect of hardwood content on tearing resistance of linerboards made from pine kraft pulp and sweetgum kraft or neutral sulfite semichemical pulps

has not been fully established that the high tear in pine kraft is always needed. For example, it may be possible to use boards with lower tear as the inner liners of a box where the stresses are less severe.

A lowering of the folding endurance was apparent even when 15% of the gum pulp was added.

Boards Containing the Gum Neutral Sulfite Semichemical Pulps

A series of linerboards was made using various percentages of gum neutral sulfite semichemical pulp refined to a freeness of 590 ml. This pulp was blended with pine sulfate pulp processed in a beater to a 575-ml. freeness; thus, the stock freenesses in the runs of this series were quite comparable.

Linerboards containing up to 25% of the gum neutral sulfite semichemical pulp had bursting strengths similar to the all-softwood board, with slightly higher ring crushes and slightly lower tearing strengths and folding endurances (Table II). As the amount of hardwood

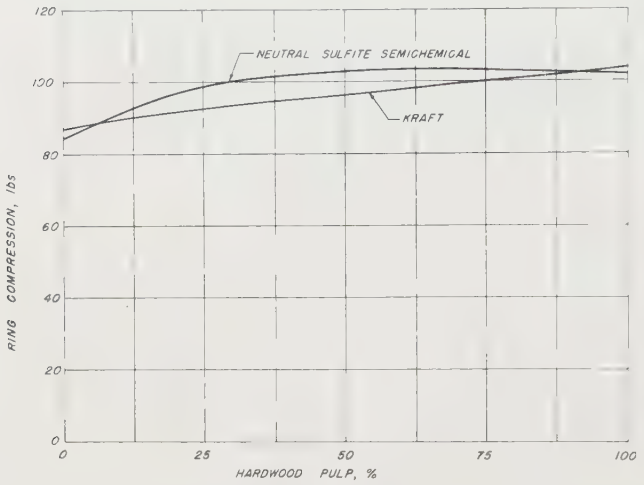


Fig. 3. Effect of hardwood content on ring compression of linerboards made from pine kraft pulp and sweetgum kraft or neutral sulfite semichemical pulps

pulp was increased beyond 25%, a general decrease occurred in all strength properties except ring compression. The all-hardwood board had about 35% lower bursting strength and 60% lower tearing strength than the all-pine board. The ring compression increased with increasing amounts of the short-fiber pulp.

It was demonstrated that the bursting strength of the boards high in content of gum neutral sulfite semichemical pulp could be raised by processing the pulp to lower freenesses. This was done without losing tearing strength; in fact, an increase in this property was noted in some instances.

Processing the gum neutral sulfite semichemical pulp to a 410-ml. freeness and using it as 75% of the furnish produced a board with a bursting strength of 102.7 points (machine run No. 4999, Table II). When this pulp was used to replace all the pine pulp, the board produced was slightly deficient in this property—enough to disqualify it for a test liner. It is reasonable to believe that, with further processing of the pulp, a board with 100-point burst could be made from it entirely.

Gum pulp additions of less than 75% did not require refining to as low as a 410-ml. freeness to develop adequate bursting strength. An intermediate-freeness pulp (475 ml.), when used as 50% of the furnish, resulted in a board with satisfactory bursting strength (machine run No. 4976). As in the previous runs, the pine kraft was beater processed to 575 ml. The furnishes containing the lower freeness gum pulp, as might be expected, drained slower on the paper machine wire and, from this point, might not be suitable for high-speed production.

The gum neutral sulfite semichemical pulp, in addition to improving the formation and surface texture, also gave a lighter colored board. The brightness increased with increasing amounts of gum pulp. The all-gum board had a brightness of about 40%, as compared to a brightness of 23% for the all-pine board. The smoother and lighter surface should be advantageous in improving the appearance of printed boxes.

Higher tearing strengths from the pine-gum blends might be achieved by processing the long-fiber component for maximum tear by refining it to a higher freeness and processing the gum pulp for maximum bursting strength. Although this was not tried, a papermaking furnish with more favorable drainage characteristics is expected to result with this procedure.

Comparison of Boards Containing Gum Sulfate Pulp with Boards Containing Gum Neutral Sulfite Semichemical Pulp

Properties of boards containing sweetgum sulfate pulp are compared with those containing sweetgum pulp prepared by the neutral sulfite semichemical process in Figs. 1, 2, and 3. These are based on pulp furnishes with similar stock freenesses. Figures 1 and 2 show that higher bursting and tearing strengths were obtained in the boards containing the gum sulfate pulp than in those containing the same percentage of gum neutral sulfite semichemical pulp, with substantial differences in boards containing these pulps at the high level of hardwood additions. These differences were also noted in the properties of the two pulps. In ring compression, however, the semichemical pulp has a slight advantage over the sulfate pulp (Fig. 3).

ROUGH HANDLING RESISTANCE OF CORRUGATED BOXES HAVING LINERS OF GUM NEUTRAL SULFITE SEMICHEMICAL PULP

Fabrication of the Boxes

Single-face corrugated board approximately 12 in. wide was made on the Laboratory's corrugator, using 26-lb. corrugating medium (made from the sweetgum neutral sulfite semichemical pulp) with experimental liners containing various percentages of the sweetgum neutral sulfite semichemical pulp. The linerboards selected all had burst values of 100 points or more, except the all-gum board which had a value of 95 points. The double-back liner was then pasted by hand to form the built-up board from which the boxes were made. Due to the narrow width of the boards (12 inches), it was necessary to piece material together to provide a sufficient width for the box blanks. The boxes made from these box blanks were $18^5/_8$ by $12^1/_4$ by $7^1/_4$ in. in size with corrugating flutes vertical in the sidewall. The corrugated material, added to increase the width of the box blanks, was all located in the

flap area of the box, so that no abnormal joints appeared in the end and side panels or at the score lines of the box. Previous studies, regarding the effect of piecing box blanks together on rough handling resistance, demonstrated that this method of fabricating the blanks would not influence the performance of the finished box when it was subjected to rough handling tests.

Method of Testing

Rough handling tests were conducted according to the single-drop test procedures described within ASTM Tentative Method D 775–57 T. This test consisted of a single drop to a 2-in.-thick steel plate embedded in a 3-ft. thick slab of concrete. The containers, each loaded with six No. 10 cans weighing 40 lb., were dropped cornerwise, and data were recorded on whether the box was sufficiently damaged to spill the contents. Each box was dropped once only. Additional boxes were dropped from various heights until the levels of highest drop with no failure and lowest drop with failure

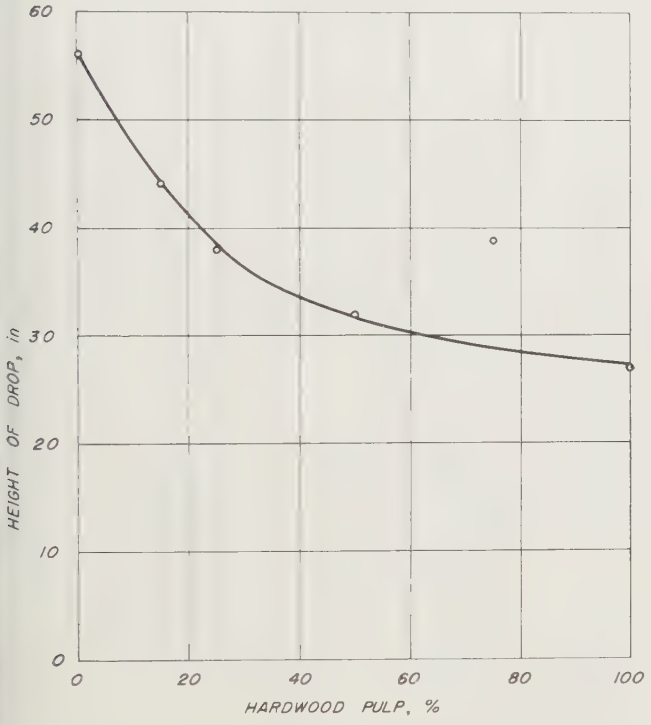


Fig. 4. Rough-handling resistance of boxes with liners containing various percentages of sweetgum neutral sulfite semichemical pulp

were established. These heights are an index to rough handling resistance.

Results

The results of corrugated container drop tests, given in Fig. 4, indicate that the addition of the hardwood neutral sulfite semichemical pulp substantially reduces the resistance of containers to rough handling. An addition of 25% neutral sulfite semichemical pulp in a kraft pulp liner furnish reduced the rough handling resistance by about 30%. Beyond this point, the effect of additional substitution is less drastic, and tests disclosed that a complete substitution of hardwood neutral sulfite semichemical pulp for the pine kraft pulp resulted in a 50% loss in rough handling resistance. Although this is a significant decrease, the level of resistance still may be sufficient for the containers to be used for packaging many products, particularly in view of the great improvement in methods for handling containers.

CORRUGATED FIBERBOARD AS A STRUCTURAL MATERIAL

During the past 15 years, considerable progress has been made at the Forest Products Laboratory in the development of design criteria for structural sandwich. A sandwich material is described as a layered construction formed by bonding two thin facings to a thick core. This definition aptly describes the usual corrugated fiberboard where the liners are the facings and the corrugated sheet forms the core. In fact, corrugated fiberboard is, in a sense, a forerunner of what is now known as a sandwich construction. Design criteria have been developed for sandwiches so that, from tension and compression tests of the facing and shear tests of the core, the strength and stiffness of the sandwich under various loading conditions can be predicted. The same engineering principles and methods used for sandwich can be applied to the design of containers.

The use of engineering formulas for predicting the strength and stiffness of corrugated fiberboard requires a different concept of testing than the usual tear, fold, burst, and tensile evaluations that are commonly used today. To utilize these formulas, new test methods are required that give stress-strain relationships for paper under both tensile and compressive loading. With such information, it is possible to take advantage of the wealth of design criteria already established for sandwich construction.

Some progress in the direction of analyzing fiberboard as a structural material has already been achieved. Test methods for determining stress-strain properties of paper and board under tensile and compressive loading have been devised. These methods were used to evaluate the properties of the linerboards used in the box tests mentioned previously.

Test Methods

Tension and compression tests were made on a machine that used mechanical drive and employed an electric, resistance-type strain gage within the load cell for measuring loads. Loads were applied at a constant rate of crosshead movement. The test machine was equipped with an autographic recorder for plotting load and testing machine crosshead movement simultaneously. Specimens were conditioned and tested at 75°F. and 50% R.H.

Tension Tests.—Tension tests were conducted according to procedures described in Forest Products Laboratory report No. 2066. Briefly, this method involved testing necked specimens, using a strain gage on the specimen at the necked portion to measure stretch or strain. Although the test specimens were $^3/_4$ by 8 in. in size, they were made with a reduced cross section (necked) of $^1/_2$ by $1^1/_2$ in. at the center to insure failure of the specimens in the region of the strain gage. Load-strain curves were plotted for each specimen, and from these curves the tensile strength, stress at the proportional limit, modulus of elasticity, and

strain at failure were computed. Six tests were made in each direction of the board.

From each group of six load-strain curves, a composite or average stress-strain curve was made. The area under the stress-strain curve was measured with a planimeter to calculate the energy to failure.

Compression Tests.—Compression tests were made on paperboard cylinders $1^1/_2$ in. in diameter and 5 in. high. Specimens were formed by winding a $4^1/_2$ by $9^1/_2$-in. sheet on a mandrel. The ends of the specimens were reinforced against localized end failure during subsequent testing by overwrapping the ends with a $^1/_2$- by $9^3/_4$-in. strip of paperboard.

During the test, the cylinders were supported inside in a manner that prevented buckling but did not otherwise influence the test. The specimens were tested in the edgewise direction of the sheet in a manner that allowed the specimens to be equally loaded around their perimeters. Two strain gages, one on either side midway along the length of the cylinder, were used to measure strains in the specimens during the test. These strain gages were modifications of the lightweight gages used to measure strains in tensile specimens and described in Forest Products Laboratory report No. 2066. The load-strain data from compression tests were used to calculate the compressive strength, stress at the proportional limit, modulus of elasticity, strain to failure, and energy at failure in the same manner as described for tensile tests.

Bending Test of Corrugated Board.—Bending tests were made on 3 by 10-in. specimens of combined corrugated fiberboard. Specimens were supported on an 8-in. span, and loads were applied using two-point loading at quarter points, that is, 2 in. from either end of the span supports. Span supports and the two-point loading head consisted of $^3/_4$-in. round pipe. This pipe diameter was large enough to prevent crushing the corrugations at the points of load application. Load application was made at a constant rate of head movement. Deflections were measured with a dial gage located at the center and beneath the span. Load deformation curves were plotted from the test data and were used to calculate the bending stiffness.

Results

The results of the tension and compression tests are given in Table III. Included in this table are strength, stress at the proportional limit, modulus of elasticity, strain at failure, and total energy to failure for linerboards containing varying percentages of the gum pulp. This table also shows that, for all boards, strength and energy to failure in tension were substantially greater than in compression. In considering the normal buckling failure that occurs when boxes are overloaded in compression, one of the liners in the buckled panel will be in tension and the other in compression, depending on which way it is bowed. Since the liners are all weaker in compression than in tension, the compressive strength of the liners is the limiting factor in box design.

Table III.—Tensile and Compressive Properties of Linerboards Containing Various Amounts of Pine Sulfate and Sweetgum Neutral Sulfite Semichemical Pulps

Properties	*Furnish*[a]					
	100% sulfate	*15% NSSC and 85% sulfate*	*25% NSSC and 75% sulfate*	*50% NSSC and 50% sulfate*	*75% NSSC and 25% sulfate*	*100% NSSC*
Machine run no.	4969	4974	4973	4976	5000	4999
Tensile Properties						
Machine direction						
Strength, p.s.i.	7,050	7,450	6,780	8,010	7,400	6,720
Stress at proportional limit, p.s.i.	2,600	2,690	2,260	2,610	2,370	2,200
Modulus of elasticity, p.s.i.	1,000,000	901,000	911,000	945,000	819,000	747,000
Strain at failure, %	1.3	1.8	1.8	2.0	2.2	2.5
Energy required to fail, in.-lb. per cu. in.	56.8	86.6	81.5	105.0	108.0	117.5
Cross-machine direction						
Strength, p.s.i.	2,840	3,240	3,010	3,070	3,300	3,220
Stress at proportional limit, p.s.i.	920	1,020	1,010	994	1,140	1,100
Modulus of elasticity, p.s.i.	318,000	392,000	336,000	359,000	382,000	379,000
Strain at failure, %	4.1	3.8	3.8	3.6	4.5	4.5
Energy required to fail, in.-lb. per cu. in.	86.0	90.0	86.4	82.6	111.7	108.7
Compressive Properties						
Machine direction						
Strength, p.s.i.	1,850	2,040	1,980	2,350	2,200	2,300
Stress at proportional limit, p.s.i.	1,380	1,410	1,460	1,800	1,600	1,750
Modulus of elasticity, p.s.i.	785,000	830,000	690,000	870,000	751,000	702,000
Strain at failure, %	0.24	0.31	0.34	0.33	0.32	0.38
Energy required to fail, in.-lb. per cu. in.	2.38	3.66	3.78	4.42	3.74	4.88
Cross-machine direction						
Strength, p.s.i.	1,160	1,230	1,190	1,350	1,500	1,670
Stress at proportional limit, p.s.i.	760	700	730	980	980	1,150
Modulus of elasticity, p.s.i.	284,000	276,000	264,000	363,000	340,000	329,000
Strain at failure, %	0.52	0.60	0.56	0.49	0.61	0.66
Energy required to fail, in.-lb. per cu. in.	3.64	4.47	3.90	3.94	5.60	6.45
Average folding endurance (MIT), double folds	890	865	528	380	209	70

[a] Composition of furnishes: sweetgum neutral sulfite semichemical pulp and southern pine sulfate pulp.

The effect of the hardwood semichemical pulp on the edgewise compressive strength is shown graphically in Fig. 5. These data indicate a steady increase in compressive strength, totaling a maximum of 20% in the machine direction and 30% in the cross-machine direction at the point where a complete substitution was made for the pine kraft pulp. From this information, the maximum crushing strength of the box can be cal-

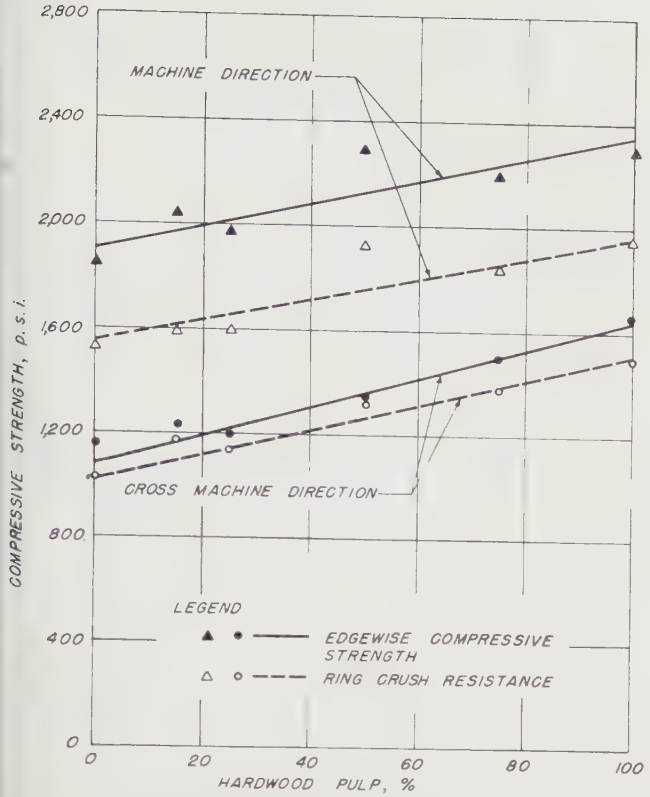


Fig. 5. Edgewise compression strength and ring crush resistance of liners containing various percentages of sweetgum neutral sulfite semichemical pulp

culated when any of these liners are employed. The maximum compressive strength of the boxes will be somewhat lower, however, because box failure under compressive loading is due to buckling of the side and end panels, rather than compressive failure of the material. Also shown in this figure is the edgewise compressive strength of these boards as determined with the usual ring crush test, but expressed in pounds per square inch. These values are all lower than the actual compressive strength of the boards, presumably due to the manner in which the specimens fail.

The effect of hardwood semichemical pulp on the modulus of elasticity or stiffness is shown in Fig. 6. The figure also reveals that, with the addition of the neutral sulfite semichemical pulp, the modulus of elasticity in the cross-machine direction increased, but decreased in the machine direction. Since fiberboard stiffness is expressed as the product of the moment of inertia multiplied by the modulus of elasticity, which is constant for most boards of the same flute size, stiffness of the combined board will vary directly with the change of modulus of elasticity. This is demonstrated in Fig. 7. These data were determined from bending tests on the corrugated fiberboard. In comparing Figs. 6 and 7, a close agreement can be seen between modulus of elasticity of the liner and stiffness of the combined board.

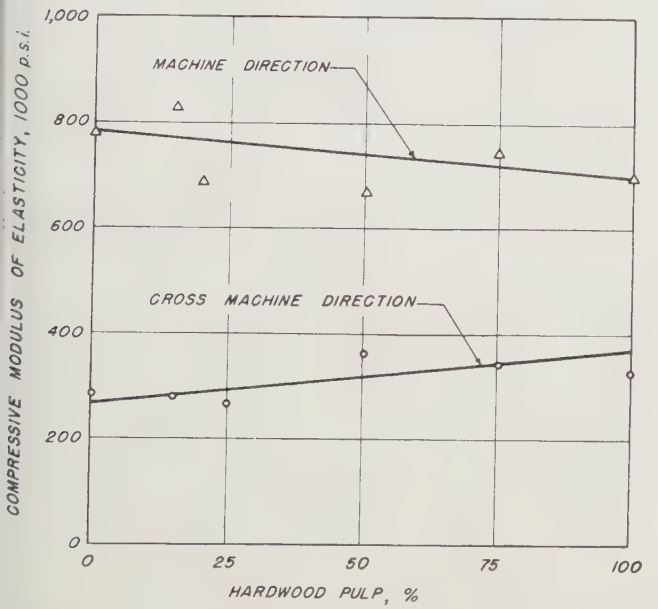


Fig. 6. Modulus of elasticity of liners containing various percentages of sweetgum neutral sulfite semichemical pulp

It is interesting to note that the modulus of elasticity of the liners has a greater influence on stiffness than does the direction in which the corrugations are placed. For example, bending tests of corrugated boards with liners containing 50% hardwood neutral sulfite semichemical pulp show that stiffness perpendicular to the flutes is 20% greater than stiffness parallel to the flutes. The stiffness of the combined board is more dependent on the properties of the liners than the corrugating medium because they are farther from the neutral axis. A material near the neutral axis contributes little or nothing to stiffness; the main purpose of such material is to separate the facings. When the corrugated flutes are perpendicular, the liners are being stressed in the direction of their highest modulus; thus, greater stiffness is recorded in these specimens. Although the board is stiffer in the direction perpendicular to the flutes, its bending strength, of course, will be greatest in the other direction.

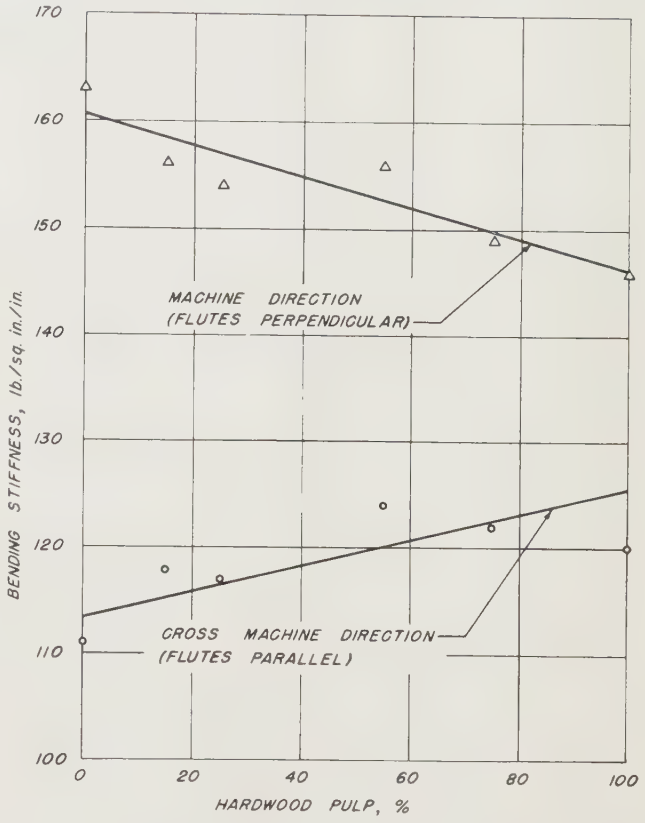


Fig. 7. Bending stiffness or corrugated fiberboard with liners containing various percentages of sweetgum neutral sulfite semichemical pulp

CONCLUSIONS

Hardwoods, pulped by either the sulfate or the neutral sulfite semichemical process and used as part of the furnish in southern kraft linerboard, improve the board's compressive properties which, in turn, provide boxes with higher stacking resistance. The test results disclose that the use of the sulfate process for pulping the hardwoods is preferable to the neutral sulfite process in preserving the bursting strength of the board. As much as 25% of either the hardwood sulfate or neutral sulfite semichemical pulp can be added without seriously affecting other strength properties, such as tear and fold.

LITERATURE CITED

1. McGovern, J. N., Mackin, G. E., and Chidester, G. H., *Fibre Containers* 33, No. 10: 35–52 (1948).
2. Carlson, T. A., *Fibre Containers* 24, No. 7: 24, 26, 28–31, 34, 35 (1939).
3. Kellicutt, K. and Landt, E., "Basic Design Data for Use of Fiberboard in Shipping Containers," U. S. Forest Prod. Lab. Rpt. 1911, 1958.

Received Feb. 19, 1960. Presented at the Meeting of the Southeastern Section of the Technical Association of the Pulp and Paper Industry, held in Charleston, S. C., Sept. 25–26, 1959.

On the Biosynthesis of Gymnospermae and Angiospermae Lignins

K. KRATZL

Application of glucose-1-C^{14} to spruce yielded after oxidation vanillin, whose activity was located preferentially the C atoms 2 and 6, in the carbonyl and methoxyl group. This result is in good agreement with the experiments performed by Acerbo, Schubert and Nord. Activity in the C atoms 2 and 6 points to the validity of the Davis-Sprinson scheme of the biogenesis of aromatic nuclei. High activity in the carbonyl group originates from a C_3 fission product of glucose added to the shikimic acid. The biogenesis of the C_3 side-chain was verified also by applying C_6-C_1-compounds (methyl-C^{14}-cresol, carbonyl-C^{14}-syringaldehyde, carbonyl-C^{14}-*p*-hydroxybenzaldehyde), although this seems to be of minor importance. Beech lignin yielded labelled syringaldehyde and syringoylacetyl after application of active coniferin. This accounts for the ease of methoxylation. Using spruce and active syringaldehyde the reverse process, namely demethoxylation to vanillin, was observed. It is believed, therefore, that methoxylation occurs at a very early stage, possibly in the phenylpyruvic acid-phenylalanin equilibrium. Furthermore, during the biogenesis of lignin precursors only a few are able to enter the pool of methoxylation equilibrium. This is shown by the fact that the plant lignins are substituted in their aromatic nuclei in a very simple and uniform way without great variation of the substituents. As soon as the *p*-hydroxycinnamic alcohols step is reached dehydrogenation and polymerization occurs, and the lignins are deposited.

According to the experiments carried out by Freudenberg (*1*) and the authors (*2*) there is no doubt that the coniferyl alcohol grouping acts as an important intermediate in the formation of gymnospermae and angiospermae lignins. However, some doubts exist on whether coniferin, the glucoside of coniferyl aclohol, shows the same importance as a precursor. On the one hand the omnipresence of coniferin had not been proved until now (*3*). The β-glucosidase on the other hand, which will be necessary for the fission of this glucoside, could not be found everywhere lignification occurs. Nevertheless, the glucoside coniferin might be important as a real precursor, since it could be shown (*4*) that its concentration in the cambium sap decreases during the period of lignification. We never observed that aromatic compounds could be degraded completely to aliphatic derivatives within the organism of plants. For example, active coniferin is converted into insoluble lignin to a very great extent. The appearance of one or the other substance in the cambium sap does not seem to prove its importance as a precursor (*3, 5*) since the stationary time of the existance of these compounds depend on too many factors, so that one is not allowed to draw many conclusions from these observations.

Prof. Dr. K. Kratzl, Organisch-Chemisches Institut der Universität Wien, Austria.

THE FORMATION OF THE AROMATIC PHENYLPROPANE PRECURSORS

If one accepts hydroxylated cinnamic alcohols as the immediate precursors of lignin, that is to say, that these compounds are the final substrates on which the biological dehydrogenation may take place, then there are two different paths of the biogenesis to be taken into consideration. The first leads from the compounds to the polymer lignin, and the problems dealing with this step have been treated extensively by Freudenberg (*1*) and our group in Vienna (*2*). We believe that we have enough experimental material about this reaction, to enable us to say that we know much about this step. On the other hand, the investigations on the biosynthesis of the arylpropane units are still being pursued.

It was Neish (*6*), the team Nord and Schubert (*7*), and Higuchi (*8*) who could show that shikimic acid plays an important role. Shikimic acid which could be found in many higher plants (*8*) seems to be an essential intermediate if carbohydrates are converted into aromatic amino acids. This metabolic path was postulated by Davis and Sprinson using the results of experiments with bacteria. Before we started our experiments it had not been definitely proved whether this scheme is also valid in the metabolism of higher plants.

Spruce branches were fed with glucose-1-C^{14}. We applied this substance by infusion of the solution

through the cut-off stem of the branches. After extraction of soluble compounds the wood was oxydized in the usual way (*9*) and it was possible to isolate a radioactive vanillin. Table I shows the results of our experiments. Applying special degradation methods we have been able to measure the activity of five definite C-atoms of vanillin (*10*). The activity of the last three C-atoms was obtained by calculation.

Vanillin is the representative of the phenylpropane unit of spruce lignin, if one neglects the two missing C-atoms of the side chain. Nevertheless, the results obtained allow conclusions to be drawn about the complete phenylpropane unit. Most of the activity of the vanillin could be found in the positions 2 and 6 of the aromatic nucleus. This points to the validity of the Davis-Sprinson scheme within this series of reactions starting from the applied glucose-1-C^{14}. At the same time Schubert and Acerbo (*11*) investigated this problem and found the same distribution of activity in 2 and 6. Furthermore, these results were confirmed by the fact that in other experiments with glucose, labelled in the same position, a similar distribution of the activity could be found in the nuclei of shikimic acid, phenylalanin and tyrosin, as is shown on Fig. 1.

Table I

			Molar activity	*Activity of vanillin, %*	*Activity of nucleus, %*
A	Vanillin	...	52.9	100.0	...
B	Carbonyl-C	...	17.3	32.7	...
C	Methoxyl-C	...	11.4	21.6	...
...	...	B + C	28.7	...	...
D	Nucleus	D = A − (B + C)	24.2	...	100.0
E	Nucleus: C2	...	9.7	18.3	40.0
F	Nucleus: C5	...	2.1	4.0	8.7
G	Nucleus: C6	...	8.0	15.1	33.1
...	...	E + F + G	19.8	...	...
H	Nucleus: C 1 + 3 + 4	H = D − (E + F + G)	4.4	8.3	18.2

FORMATION OF THE SIDE CHAIN

Two possibilities are taken into consideration. The side chain can be formed by condensation of a C_3-unit with the nucleus, as in the case of the aromatic amino acids. On the other hand, addition of a C_2-unit to a preformed C_6-C_1 unit might be possible. This last possibility is assumed on the basis of results obtained by Neish (*6*). Application of labelled C_6-C_1 compounds (e.g., vanillin) yielded not only active degradation products of the C_6-C_1 type but also C_6-C_3 compounds, as could be shown by the isolation of dihydroconiferyl alcohol, which was obtained recently after high pressure hydrogenation. We investigated this problem (*12*) and used creosol-methyl-C^{14} as a model compound, which shows no resemblance to any natural precursor. An active lignin was formed with this compound. It is remarkable that this lignin gave an active vanilloylacetyl. And, although only low

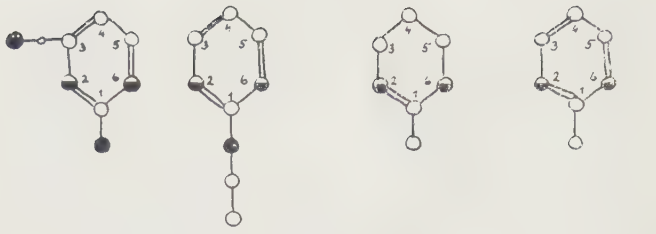


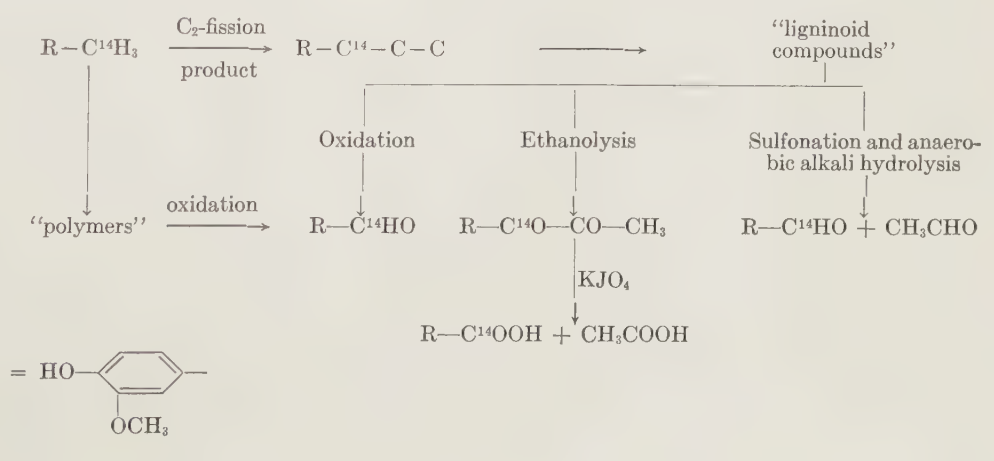
Fig. 1

yields were obtainable the distribution of activity in this compound could be localized, as is shown schematically in Table II. This result was confirmed by sulfonation of the lignin and subsequent alkaline hydrolysis of the ligninsulfonic acid. Thus, plants are able to convert artificial and quite unnatural C_6-C_1 compounds into C_6-C_3 compounds which are necessary for their vital functions. Although the extent of this conversion was not very high it shows clearly the tendency of plant metabolism to utilize even very unnatural and very different compounds which, probably in common pools, are converted into those substances which may act as natural precursors. In this example the pregiven artificial compound was converted into typical precursors of lignin.

May I again draw your attention to our experiments with labelled glucose, in connection with the well-known scheme of Davis and Sprinson (Fig. 2). Shikimic acid adds a C_3-fission product of the "glycolyse" cycle which definitely derives from glucose. In this step the C atom of the carboxyl group of shikimic acid is lost, which in our case must be inactive. As could be shown by experiment, (see Fig. 1), the isolated vanillin possessed activity not only in the C atoms 2 and 6 of the aromatic nucleus but also to a high extent in the carbonyl group. We, therefore, assume that during formation of prephenic acid a normal C_3-fission product of glucose has been added without previous degradation to smaller fragments. Only by this can the high activity in the C atom of the carbonyl group of vanillin be explained.

On the other hand, we do not believe that in case of the natural biogenesis of lignin the precursors are formed via condensation of C_6-C_1 units and a C_2 compound, although the C_6-C_1 compound could, without any doubt, originate by a direct process of aromatiza-

Table II



tion of 5-dehydroshikimic acid or shikimic acid itself, as has been proved in case of the formation of protocatechuic acid. But the distribution of activity found in the vanillin skeleton opposes this assumption. About the activity which could be found in the methoxyl group of vanillin, I will report somewhat later.

Aromatic compounds of the plant kingdom could be formed by another series of reactions starting from acetic acid. This mechanism was postulated by Birch and Donovan. We tested this way by means of labelled acetate and could show that it plays no role in the biogenesis of lignin (*10*). Although a weekly active lignin could be isolated, one has to assume that, according to Ehrensvärd (*13*), acetate on a small scale was converted into glucose which then is responsible for the formation of the active lignin in the usual manner, as mentioned above.

The validity of the Davis-Sprinson scheme in the biogenesis of other natural phenylpropane units was proved by Weygand (*14*) who investigated the biogenesis of coumarin in the roots of *Mellilotus officinalis*.

A very interesting intermediate in all these reaction series seems to be the *p*-hydroxyphenylpyruvic acid. As Nord (*7*) has shown this compound is converted into lignin in a high yield, whereby sugar cane was used. Nord assumes that this compound should be an intermediate of general importance in biogenesis of all lignins. On the other hand, we found that contrary to the results obtained by Nord *p*-hydroxyphenylpyruvic acid does not act as an efficient precursor if gymnospermae (spruce) is used (*15*). For comparison we used coniferin in control experiments, and isolated not only C_6-C_1 compounds (aldehyds obtained by oxydation) but also the C_6-C_3 compounds (vanilloylacetyl obtained by ethanolysis). This descrepancy was clarified by Brown and Neish (*16*) who found that only graminae (sugar cane) is able to convert *p*-hydroxyphenylpyruvic acid. As has been shown by Neish (*6*) in prior experiments these organisms do not only use this compound to build up the *p*-hydroxy building stones of their lignin, but also are able to methoxylate the nucleus, whereby, ferulic and sinapic acid is formed. Another path of biogenesis runs via phenylpyruvic acid.

It is not yet clearly established whether phenylalanin lies on the direct route between the carbohydrates and the lignins. Phenylalanin acts as a very efficient precursor in the formation of lignin. Besides this, Freudenberg (*1*) was able to isolate active coniferin after feeding the plants with labelled phenylalanin. Finally, even tyrosin is used as an efficient precursor in gramineae (*17*).

THE FORMATION OF ANGIOSPERMAE LIGNINS

The lignin of angiospermae, which contains syringa units has not been subjected to extensive investigations with respect to its biogenesis until now. Neish (*6*) showed, in many papers, that after feeding the plants with unsubstituted precursors methoxylation of the aromatic nucleus may occur to a great extent. Recently, with my co-workers Puschmann and Simon (*18*), I started investigations on methoxylation and demethoxylation of the aromatic nucleus. In this field the methods of degradation are more complicated since they afford separation of differently substituted degradation products. The separation of degradation products obtained after ethanolysis of the lignin was possible and is published in a paper with Buchtela (*19*). These methods could be improved by means of thin-layer chromatography (*18*). We tested the applied methods of degradation and separation by means of a crossed DHP (dehydration polymerisate) between coniferyl alcohol and sinapin alcohol.

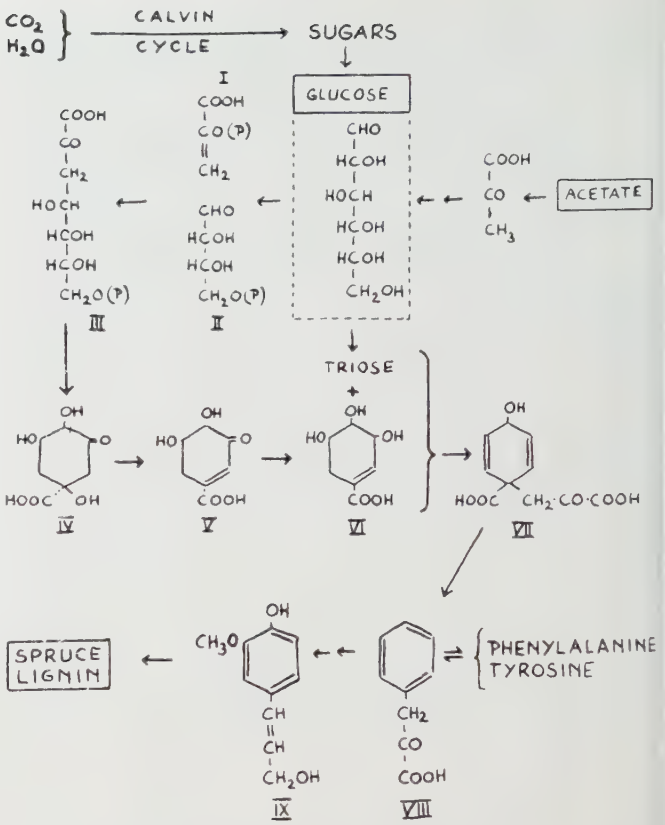


Fig. 2

I: Phospho-enol-pyruvic acid. II: D-erythrose-4-phosphate. III: 2-keto-3-deoxy-7-phosphoglucoheptonic acid IV: Dehydroquinic acid. V: Dehydroshikimic acid. VI: Shikimic acid. VII: Prephenic acid. VIII: Phenylpyruvic acid. IX: Coniferyl alcohol.

The investigations of methoxylation and demethoxylation were performed in two various series of experiments. In Series 1 we used spruce (*Picea excelsa*) as a representative of gymnospermae and we fed this plant with syringin and syringaaldehyde, substances which are quite unusual in the metabolism of gymnospermae. Series 2 was undertaken with beech (*Fague sylvatica*) and lilac (*Syringa vulgaris*) which were fed with coniferin. All applied substances were labelled in the side-chain in the position near the nucleus. Oxidation of the lignin yielded a mixture of the aldehydes, ethanolysis gave a mixture of the diketones (vanilloylacetyl and syringoylacetyl).

Thereby, it could be shown, without any doubt, that spruce is able to incorporate the unnatural syringa units into its lignin. In case of the applied syringin even the structural element, which allows ethanolysis, is preserved at least partly. This seems to be contrary to the findings of Reznik (*20*), who could not observe any incorporation of syringin into spruce lignin. In our experiments it was observed that on a small scale an artificial condensation of a C_6-C_1 unit (syringaaldehyde) with a C_2 unit occurred, as an active phenylpropane unit (syringoylacetyl) was later isolated.

But the experiments in Series 1 revealed another, still more interesting fact, i.e., that demethoxylation had occurred. Feeding of spruce with active syringaaldehyde yielded active vanillin. Although the yield of the vanillin was low, the conversion of syringa units into guajacyl derivatives took place. Similar observations are to be found in the papers by Neish (*6*). The mechanism of this reaction is still unknown.

This is another example which shows the tendency of plant metabolism to synthesize the necessary precursors at all stages, and even starting from unnatural products. On the other hand, one may assume the existance of an equilibrium between methoxylated and unmethoxylated precursors, since interconversion of various applied aromatic substances has been proved. Of course within the natural pathway of biogenesis—and without applying and adding external substances—methoxylation could possibly occur at an earlier stage, perhaps on phenylpyruvic acid or similar compounds.

In the second series of experiments made with beech and labelled coniferin, degradation yielded syringa units, which after separation (vanillin/syringaldehyde, vanilloylacetyl/syringoylacetyl) possessed remarkable activity. The ability of plants to perform methoxylation reactions could undoubtedly again be proved. The first step in this reaction seems to be the introduction of a hydroxyl group, a process which is well known in biochemistry. The methyl group is supplied by methionin. Furthermore, Bjerrum (*21*) showed another way of a possible formation of methoxyl groups, i.e., ribulose-5-phosphate, xylulose-5-phosphate, glycolic acid. This path possibly accounts for the high activity we found in the methoxyl group of the vanillin obtained in our experiments with glucose-1-C^{14}.

Finally, I would like to point to the fact that after feeding spruce with syringin, this compound was incorporated in such a way that it later appeared in those structural elements which are able to be degraded by ethanolysis. This means that even unnatural but similar compounds are oxidized to the corresponding arylglycerol which subsequently is linked by β-ether bonds. A similar reaction was observed on the DHP of sinapin alcohol. Now it seems probable that methoxylation of the aromatic nucleus occurs at a very early stage, possibly on phenylpyruvic acid or phenylalanin. This means that the added precursor (e.g., coniferin) is methoxylated first until the proper degree of methoxylation is reached, and only later do all those reactions occur which make possible the polymerization into lignin via β-ether (*12*) bond types.

SUMMARY

During formation of lignin the coniferyl alcohol plays an important role as an immediate precursor, whereas, its glucoside coniferin may be regarded rather as a storage or transport system. The formation of the aromatic precursor was investigated by means of glucose-1-C^{14} (spruce, infusion).

The activity was measured in five of the eight C-atoms of vanillin obtained after oxidation of the active lignin. The high activity in the positions 2 and 6 of the aromatic nucleus points to the validity of the Davis-Sprinson scheme. In addition, the high activity found in the carbonyl group of vanillin led to the assumption that a C_3 fission-product of glucose was added to shikimic acid which, in this step, lost its carboxyl group.

Another possibility of condensation, namely, $C_7 + C_2$ was verified by application of creosol-methyl-C^{14} but seems to be of minor importance. The formation of the phenylpropan unit is compared with the biosynthesis of coumarin (Weygand). *p*-Hydroxylphenylpyruvic acid is incorporated into spruce lignin only at a very small scale, as could be shown in the experiments of Billek. According to Neish this compound is efficient as a precursor only in monocotyledons.

The biogenesis of the lignin of angiospermae was investigated with Puschmann and Simon. Beech lignin which was fed with labelled coniferin yielded active syringaaldehyde and syringoylacetyl, which accounts for the ready methoxylation. The reverse process seems to be more interesting and was shown using spruce and labelled syringa units. Demethoxylation to vanillin units was observed.

It is believed that methoxylation occurs at a very early stage, possibly in the phenylpyruvic acid-phenylalanin equilibrium, and furthermore, that only few precursors enter the pool of the methoxylation equilibrium. Therefore, the lignin of plants shows only very little variation, according to its substitution on the aromatic nucleus, while the same organism is able to produce a broad spectrum of other phenolic compounds, but of low molecular weight.

LITERATURE CITED

1. K. Freudenberg, H. Reznik, W. Fuchs, and M. Reichert, *Naturwiss.* 42: 29 (1955).
   K. Freudenberg in "Biochemistry of Wood," ed. K. Kratzl and G. Billek, London, Pergamon Press, 1959, p. 121.
2. K. Kratzl and G. Billek, *Tappi* 40: 269 (1957); *Holzforschung* 10: 161 (1956).
   K. Kratzl in "Biochemistry of Wood," *op. cit.*, page 247.
   G. Billek in "Biochemistry of Wood," *op. cit.*, page 207.
3. C. M. Stewart, *Tappi* 40: 244 (1957).
   R. O. Kremers, *Tappi* 40: 262 (1957).
4. van Rijn in "Die Glycoside," 2. Aufl. 1931, page 10.
   V. Plouvier in "Die Glycoside," 2. Aufll. 1931, page 37.
   N. I. Nikitin, "Die Chemie des Holzes," Akad. Verlag Berlin, 1955, page 329.
5. J. B. Mugg, *Tappi* 42: 289 (1959).
6. S. A. Brown and A. C. Neish, *J. Amer. Chem. Soc.* 81: 2419 (1959).
7. F. F. Nord and W. J. Schubert, *Tappi* 40: 285 (1957).
   F. F. Nord in "Biochemistry of Wood," *op. cit.*, page 189.
8. T. Higuchi in "Biochemistry of Wood," *op. cit.*, page 161.
9. K. Freudenberg, W. Lautsch, and K. Engler, *Ber. dtsch. chem. Ges.* 73: 167 (1940).
10. K. Kratzl and H. Faigle, *Mh. Chem.* 90: 768 (1958), *Z. Naturforsch.* 15b: 3 (1960).
11. W. J. Schubert and S. W. Acerbo, *Arch. Biochem. Biophys.* 83: 178 (1959).
12. K. Kratzl, W. Kisser, A. Graf, and G. Hofbauer, *Mh. Chem.* 90: 526 (1959).
13. L. Reio and G. Ehrensvärd, in "Biochemistry of Nitrogen," Helsinki Acad. Scient. Fennica, 1955, page 389.
14. F. Weygand and H. Wendt, *Z. Naturforsch.* 14 b: 421 (1959).
15. K. Kratzl and G. Billek, *Mh. Chem.* 90: 536 (1959).
16. S. A. Brown, D. Wright, and A. C. Neish, *Canad. J. Biochem. Physiol.* 37: 25 (1959).
17. D. R. McCalla and A. C. Neish, *Canad. J. Biochem. Physiol.* 37: 531, 537 (1959).
18. K. Kratzl and G. Puschmann, *Holzforschung*, 14: 1 (1960).
    K. Kratzl and H. Simon, unpublished data.
19. K. Kratzl and K. Buchtela, *Mh. Chem.* 90: 1 (1959).
20. H. Reznik in "Biochemistry of Wood," *op. cit.*, page 70.
21. R. L. Hamill, R. V. Bjerrum, and C. D. Ball, *J. Biol. Chem.* 224: 713 (1957).
22. E. Adler in "Biochemistry of Wood," *op. cit.*, page 137.

Received April 7, 1960. To be presented at the 5th World Forestry Congress, in Seattle, Wash., August 29, to September 10, 1960.

Clarification of High Color Waters

C. T. WISE

The quality of water required for the production of high-brightness paper warrants a thorough investigation of the water treatment facilities. High color, low turbidity surface water is one of the most difficult water to clarify. It should be the responsibility of the Owner's engineers to provide engineering documents which are sufficiently rigid to assure fair competition among the contractors and suppliers and to provide the required quality of water at reasonable operating costs.

THE quality of water required for the production of high-brightness paper warrants a thorough investigation of the available water suppliesand a very careful design of the water treatment facilities (*2*). High color, low turbidity surface water is one of the most difficult water to clarify. There is no modern, magic method for the engineer to use in solving the problem. The answer lies, perhaps, in the enlargement and refinement of established and proved methods in the water treatment field. However, engineers should be alert to utilize to the best advantage any new developments in processes, materials, equipment, or chemicals which could produce a better quality water at a lower capital or operating cost. Costs for treating this type of water are usually relatively high and should be very carefully evaluated. In fact, if the color is expected to be continuously excessively high, say above 200 or 300 p.p.m., the possibility of obtaining another source of water should be investigated.

The unit processes discussed briefly in this report will be chemical treatment, mixing, coagulation, sedimentation, filtration, and water storage, all as applied to relatively large water-treatment plants. Because of the limited time alloted for this presentation, it will be possible to cover only the broad aspects of this water treatment problem. No attempt will be made to evaluate all of the various types of processes and equipment now on the market. The methods described are some of those which have been successfully used by our company. They should not be construed as the only designs that will give satisfactory results.

The relative merits of conventional horizontal-flow, flocculation-settling units and the up-flow, sludge-contact units are beyond the scope of this discussion. Both types have been used successfully when properly designed for the specific service. The conventional units have been found to be sometimes better capable of adjusting to sudden changes in flow or character of the raw water. The records indicate that the up-flow units generally have been installed at a somewhat lower cost, but require more diligent attention by the operator to minimize the effects of the changes in flow or composition. A more conservative rating of the up-flow units would tend to reduce these differential characteristics.

C. T. WISE, J. E. Sirrine Co., Engineers and Architects, Greenville, S. C.

CHEMICAL TREATMENT

The use of the proper coagulants, coagulant aids, and rates of chemical feed is extremely important in the coagulation of high color water. Our experience indicates that where the color in the raw water does not exceed about 150 to 200 p.p.m., provisions for feeding alum, lime, chlorine, and one of the polyelectrolyte coagulant aids or activated silica are usually adequate. If the color is higher, additional coagulant aids or weighting agents may be required. For difficult waters extensive laboratory coagulation tests should be made over an extended period of time before the treatment plant is designed and the chemical feed equipment is selected. If the water is also the potable supply, it should be determined that the proposed coagulant aids have been approved by the health authorities. Standby feeding equipment which can be used during malfunctions and can be utilized for feeding other coagulants should be provided.

The points of feed of the coagulants should be given careful consideration. It is considered good practice to feed the coagulants into the raw water mixing chamber with the coagulant-aid being fed in the flocculation zone after the floc has begun to form. It is desirable to provide the chemical solution feed piping so that the feed of alum and coagulant-aid may be split, if desired, feeding a part into the raw water mixing compartment, and a part into the flocculation basin. Care should be taken that the chemicals are discharged into the basins at a point where maximum diffusion will be obtained and where short-circuiting will be minimized.

Chemical treatment for corrosion and sterilization of the finished water is of course required. Additional chemical treatment for specific conditions may also be required.

At the Hudson Pulp and Paper Corp. plant at Palatka, Fla., the color in the raw surface water ranges from 50 to 500 p.p.m. The high color occurred after heavy rains in the area. The experiences in the treatment of this water at the Hudson Pulp & Paper Corp. have been described by McInnis, Mills, and Collins (*1*). After rather extensive laboratory tests as well as plant scale experiments during which many coagulants and coagulant aids were tried, it was developed that adequate results could be obtained with the use of alum, lime, chlorine, clay, and Separan. Only a fraction of a p.p.m. of Separan was needed during the periods of high color. For the low-color range the optimum coagulation pH range was found to be as high as 6.8 and for the high-color range the optimum pH was as low as 4.8. With careful control of the chemical dosages the color of the water after filtration could be held at 5 to 15 p.p.m.

This water treatment plant is shown in Fig. 1.

MIXING

It is believed that for treating high color water, a separate flash mixing stage should be provided. This provides better assurance of thorough dispersion of the chemicals in the water before any floc is formed. This feature also provides more flexibility in the points of

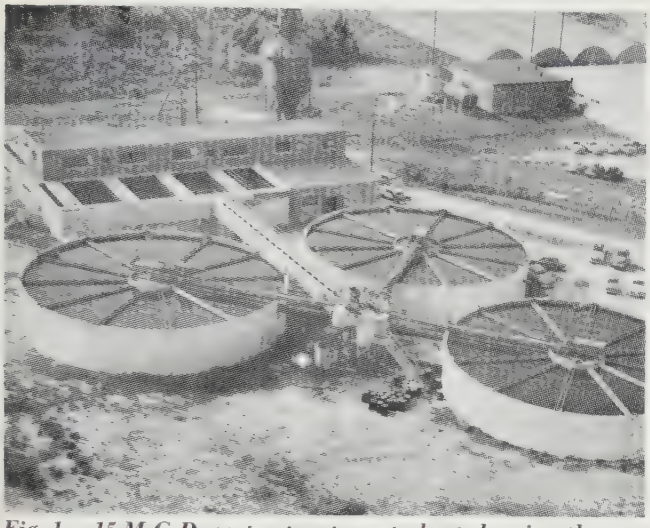


Fig. 1. 15 M.G.D. water treatment plant showing the raw water mixing basin and the clarifiers in the foreground with the filtration plant in the background

feed of chemicals in the process. There are many good mixers on the market. Care should be exercised that full flowthrough be obtained. In-the-line mixers have been used successfully on some of our projects.

COAGULATION

It is our opinion that coagulation is one of the most important stages in the pretreatment of water, especially low-solids water. A detention in the flocculation zone of 40 to 60 min. is desirable. For up-flow, sludge contact type units, it appears reasonable that a part of the sludge contact zone may be considered as a part of the flocculation stage. A gentle rolling agitation that will agglomerate and not disintegrate the floc is required. Violent agitation in any part of the basin should be avoided. Of the many types of mechanical agitators available, reasonably comparable results should be expected provided the proper velocities are maintained throughout the entire basin. The floc in high color, low solids water is normally light, feathery, and delicate. It is difficult to build up and easy to break down. The coagulant aids help in providing tougher, denser floc.

It is desirable that multi-speed or variable-speed drives be provided for the agitating equipment. This will provide flexibility in the selection of the speed that will give the best results. It is important in the design of the coagulation basin that every precaution be taken to properly distribute the water entering and the water leaving each compartment so as to obtain the maximum flowthrough time. The recirculation of sludge to the coagulation basin is helpful in the agglomeration of larger and denser floc particles.

SEDIMENTATION

The relatively difficult settling characteristics of the light color floc justifies a careful design of the sedimentation basins. Here again it is of extreme importance that every reasonable precaution be taken to eliminate short-circuiting of flow through the basin (*3*). A step in the right direction is the equal distribution of the influent and the effluent across the full width of the

Fig. 2. 20 M.G.D. water treatment plant showing the collecting flumes in the horizontal flow type settling basins and the filter beds in the foreground with the filter operating gallery, laboratory and chemical feed-room in the background

basin normal to the direction of flow. Properly spaced and sized submerged orifices have been found to be a successful method of distributing the flow into and from a basin.

It is considered that, for a water with a difficult settling floc, the detention in a conventional horizontal-flow basin should be 4 to 5 hr, and the detention in an up-flow, sludge contact type basin should be 2 to 2.5 hr. in the sedimentation compartments. For the up-flow type unit, it is thought that the rise-rate should be limited to 0.50 or 0.75 g.p.m. per sq. ft. of surface, although higher rates have been used under certain conditions. Where practical, effluent troughs should be spaced to limit the total flow into the trough from both sides to about 12 g.p.m. per linear foot of trough.

The necessity of mechanical sludge removal is dictated by the type of settling basin and the rate of accumulation of sludge. Continuous sludge removal is usually desirable for water treatment plants for industries where the water demand is fairly steady and continuous for 24-hr. days and 7-day weeks. The sludge removal equipment eliminates the necessity of taking a unit out of the system for cleaning and the resulting overloading of parallel units during this outage. The continuous control of the depth of sludge in the basins provides for more efficient settling when compared with a basin that is partly filled with sludge.

Figure 2 shows the effluent end of a typical horizontal-flow type sedimentation basin.

FILTRATION

An important factor in the design of filter beds is the rate of filtration. For a high color, low-solids water it can be expected that, in spite of all precautions taken to properly condition the water before filtration, there are going to be times when some floc carryover to the beds will occur. In view of this, it is thought that a reasonable design rate is 2.5 g.p.m. per sq. ft. of bed, but that the hydraulic capacity should be approximately 4.0 g.p.m. This maximum rate will provide for possible intermittent peak loads, for outage of a

Fig. 3. 25 M.G.D. water treatment plant showing the filter operating gallery with the filters in the open on each side

unit for maintenance, and for possible future upgrading of the capacity of the plant if operating experience warrants.

An economic saving is effected by the use of the largest size filter units that will provide the desired flexibility of operation. In most of our large plants, twin units have been used to an economic advantage. With this arrangement half of the twin unit is washed at a time.

There are many filter underdrain systems on the market. In selecting the underdrain, care should be exercised that proper distribution is obtained when filtering and when backwashing, that adequate insurance against plugging of small ports is provided, that the materials will resist corrosion, and that adequate structural strength is provided.

The filter media for most of our plants has been silica sand. The effective size has been in the range of 0.40 to 0.50 mm. and the uniformity coefficient has been less than 1.5. Sufficient backwash water has been provided to give a sand expansion of approximately 50%. This generally requires a wash rate equal to a rise of 30 to 36 in. per min. With an adequately designed bed and backwash facilities, it is believed that surface wash facilities generally are not justified for a low turbidity water. However, some engineers prefer the use of surface wash and a larger effective size of sand. The filter runs between washes usually range from 24 to 100 hr. depending on the quality of the raw water, the pretreatment, and the diligence of the operators. In some sections of the country, the use of antrafilt as the filter media is justified.

A typical filter operating gallery with the filter beds on each side is shown in Fig. 3.

WATER STORAGE

Adequate storage capacity of the finished water is important for this type of treatment plant. It is believed that, in order to minimize the effect on the plant of sudden changes, a fairly constant flow rate of raw water is desirable. The short duration peak de-

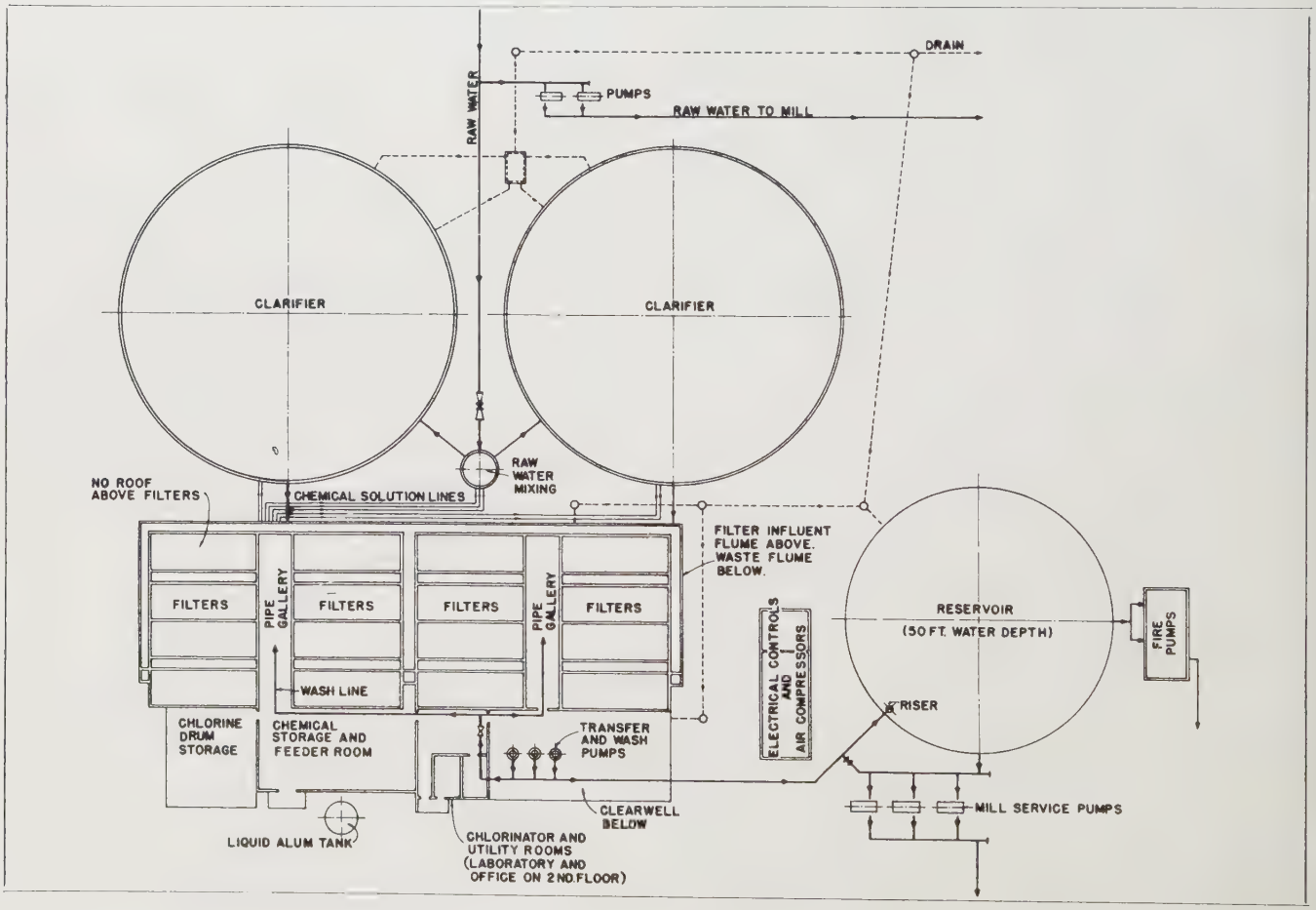


Fig. 4. 30 M.G.D. water treatment plant

mands for finished water should be absorbed by the water storage reservoir. The storage capacity should be adequate, of course, for any expected emergency failure in the treatment system. The required storage capacity will be influenced by the available flexibility of operation of the treatment plant, including reserve capacity, standby equipment, and means of by-passing units of the process.

An economical and satisfactory water collection and storage system has been found to be a clearwell of nominal capacity, from which the water is pumped by transfer pumps to a steel or concrete reservoir with a depth of 50 or 60 ft. This arrangement provides for an economically proportioned reservoir and a means of backwashing the filters from the same system. With this arrangement it is necessary to provide automatic controls for the transfer pumps and the filter effluent rate-of-flow controllers, these controls being actuated by the changes in the water level in the clearwell. With this system of maintaining a constant raw water rate of flow, it is necessary to provide means of allowing the water level in the clarifiers and the filter beds to fluctuate. This fluctuation in water level can be restricted normally to about 12 in.

A raw water storage reservoir will smooth out the sudden variations in the quality of the raw water. This would be beneficial in reducing the effect on the clarification process. However, it is usually difficult to justify this additional cost. It is believed that a practical compromise is a design of the treatment system to allow for an expected modified change in flow. Any radical change in the quality of the raw water usually can be anticipated by the filter plant operator who should be able to make the necessary adjustments to maintain the desired quality of the finished water.

A suggested water storage and pumping system is indicated in Fig. 4 as a part of a water treatment plant now under construction in the Southeast.

CONCLUSION

Because a high color, low solids water is difficult to clarify, it is apparent that each unit operation of the water treatment system should be very carefully studied and adequately designed for the treatment of the specific water. It should be the duty of the designer of the water treatment plant to provide plans and specifications sufficiently rigid to assure that all contractors and equipment manufacturers are proposing comparable construction, materials, and equipment. It is believed that the designer should include in his specifications required detentions, rise rates, velocities, basin influent and effluent limitations, filter rates, wash rates, and other functional requirements that appear necessary to insure fair competition among the contractors and equipment suppliers and to provide for the required quantity and quality of water at the least cost.

LITERATURE CITED

1. McInnis, J. S., Mills, R. H., and Collins, T. T., Jr., *Paper Trade J.* (July, 1958).
2. Hazen, R., *Tappi* Vol. 41, No. 4: 210A (April, 1958).
3. Howson, L. R. and Aultman, W. W., *J. American Water Works Assoc.* Vol. 47, No. 8: (Aug., 1955).

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Cord Fatigue in Fleet Tested Tires

W. G. KLEIN, M. M. PLATT, and W. J. HAMBURGER

This is a progress report on a continuing research which is aimed at delineating the nature of cord fatigue in tires. The first stage of this study deals with the properties of cords and filaments removed from tires run on a New York taxi fleet, and includes usage up to 100,000 miles. The major emphasis was on tires constructed of Tyrex viscose cord, but corresponding studies were also made on a smaller group of nylon cord tires. Some previous work on this problem indicated that a linear degradation of cord tensile strength with mileage might be anticipated, and implied that the rate of change of cord tensile strength could be taken as a measure of fatigue resistance. The current studies performed on the tires from this test indicate that: (a) there is an initial loss of cord strength of about 10 to 15%, occurring within the first 20,000 miles, followed by a long period of very gradually diminishing strength, (b) while there is a trend for a small loss in fiber strength with mileage, it is not correlative with cord strength losses, (c) the strength loss in the few severely weakened cords found was attributable to filament breakage, (d) no unusual strength losses were observed in intact cords from tires classified as fatigue failures. Some observations on the role of adhesion, pertinent to the problem, are presented.

Of the several types of tire failure encountered, one of the most discussed and least understood has been so-called "tire cord fatigue." The only point of real agreement has been that fatigue failure is characterized by circumferential cracks in the regions of maximum flexing. Since such failure is usually initiated in the inner ply, which is subject to considerable compression, the name "compression fatigue" has frequently been applied.

Undoubtedly, a considerable amount of private research has been done on this subject which, due to the economic advantages involved, has remained unpublished, but to our knowledge two recent pieces of research bearing pertinently on the problem have come to the public's attention. They are those of Williams, *et al.* (*1*) and Entwistle, *et al.* (*2*). These articles are considered of particular interest because they deal with the properties of cords and filaments removed from tires rather than, as with the bulk of the work in the field, laboratory fatigue tests whose correlation with service conditions has been difficult to establish. Before noting the points of agreement and disparity among these articles and our own, it would be well to describe briefly the manner in which the tires were used.

All tires considered were fleet tested. In the Williams

W. G. Klein, Senior Research Associate, M. M. Platt, Associate Director, and W. J. Hamburger, Director, Fabric Research Laboratories, Inc., Dedham, Mass.

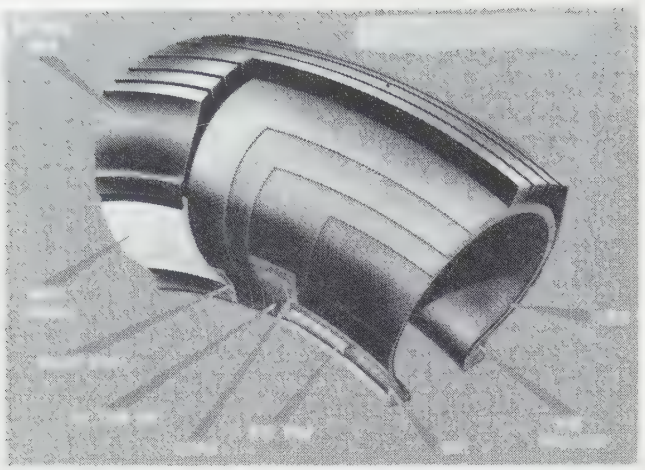


Fig. 1. Construction elements of passenger tire

and Entwistle work they were subjected to conditions of overload and underinflation for mileages up to about 30,000, while in the present work the tires were run at rated pressures and loads up to 100,000 miles.

The most important point of agreement in all three is that cord strength losses are at a maximum in the flex zone and that filament strength losses are much too small to account for cord strength losses. Thus it is assumed that broken filaments rather than a degradation of those intact are responsible for cord strength losses. This has been semiquantitatively justified by examination of weakened cords.

The most important point of disagreement is the rate of cord strength degradation. While Williams states that a linear rate of cord strength loss with mileage exists and concludes that this rate is an index of fatigue resistance, both the Entwistle work and our own show an initial low-mileage nominal loss of strength followed by a long period of very gradually diminishing strength, and consequently require a more complicated view of the mechanism of fatigue. Such a view will be presented and justified logically if not conclusively.

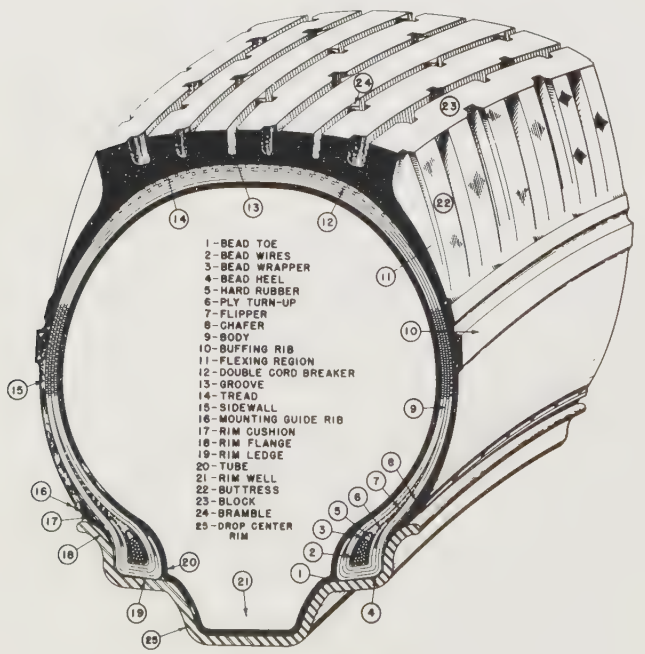


Fig. 2. Passenger tire section

The resolution of this disparity is of importance in two ways. First, the roles of materials and construction cannot be properly understood without a knowledge of the basic mechanisms involved in fatigue and second, the very inexact art of accelerated laboratory fatigue testing cannot be improved without knowing what goes on in a tire.

It is the purpose of this paper to present the results of tire analyses made on tires from a New York taxi fleet test and to suggest conclusions which might be drawn on the basis of these, the above referenced articles, and several conferences with major tire producers.

THE TAXI FLEET TEST

A complete description of the taxi fleet test together with some early observations on tread wear, retreadability, etc., is found in a paper by Breazeale (*3*). The present brief description is simply to familiarize the reader with the test conditions.

All tires were made by the same manufacturer at the same time and all are 7.50 × 14, tubeless. Five different tire cords were used and each was represented by 100 tires in the fleet. Table I, reproduced from reference (*3*), gives the pertinent construction parameters of the tires involved in this test.

Each of the Tyrex viscose cords series was supplied in duplicate by two different producers, hereinafter designated simply as "A" and "B." Thus while five different cords were used there are only three nominal types. Each of the five different cords was represented by a sampling of from 6 to 14 tires. The exact number of each can be found by reference to subsequent graphs where the points for the individual tires are plotted.

Table I

Material	*1100/2 Tyrex viscose cord*	*1650/2 Tyrex viscose cord*	*840/2 Nylon*
Ends/in.	36	27	30
Twist	15 × 15	12 × 12	12 × 12
B. D. tensile, lb.	23.7	36.6	30.3
Carcass tensile, lb./in.	3400	3940	3640

It should be noted that the values shown in the Table I are for the moisture-free state. All testing in the present work was done at 70°F., 65% R.H., and is thus not directly comparable to the above.

This test differs from most others in that rated pressure and load were maintained under constant surveillance, thus avoiding accelerated degradations which might not be correlative with normal wear.

Tires for analysis were selected from the test in two ways:

1. At selected intervals of mileage, a few tires not exhibiting any outward signs of fatigue were removed from service for dissection and analysis.
2. All tires diagnosed as fatigue failures were similarly dissected and analyzed.

Data are included here covering zero to 100,000 miles with recapping occurring at approximately 20,000-mile intervals.

Tests Performed

Figures 1 and 2* show respectively cutaway and cross-sectional views of passenger tires. The cutaway view

* Photographs courtesy of U. S. Rubber Co., Detroit, Mich.

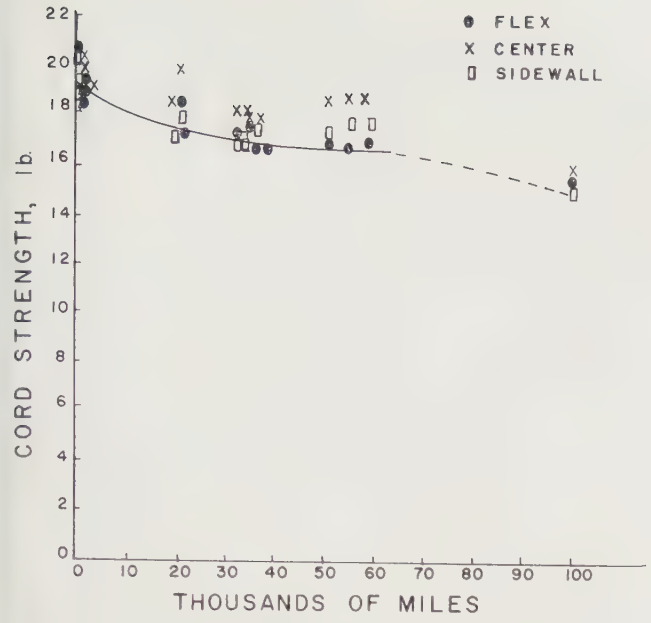


Fig. 3. Cord strength versus tire mileage; viscose A, 1100/2

is from a tubeless tire similar to those considered in this report; the cross section is from a tube type, differing primarily in the substitution of a tube for the liner. It will be convenient for the reader not familiar with tire construction to refer to these from time to time during the following discussion and descriptions.

The tires were dissected by cutting out a segment of about 90° and stripping off the rubber liner. This exposed the first, or inner, ply cords to easy removal. Four separate areas of investigation can be defined:

Cord Strength. Cords were stripped from the 1st ply and tested at low extension rates on an Instron tensile tester using capstan jaws and a free gage length of 2 in. Three regions of the cord were considered:

Crown—the center of the test specimen at the center of the cord, corresponding to the crown position on the tire.

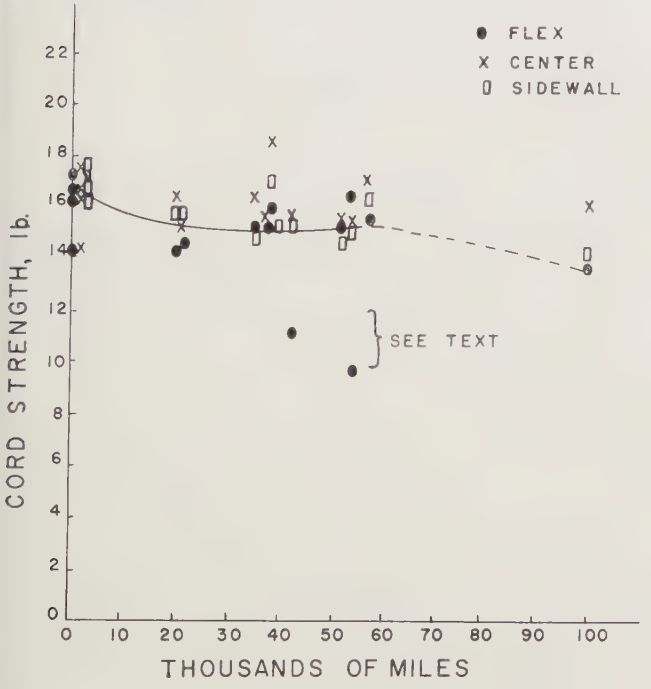


Fig. 4. Cord strength versus tire mileage; viscose B, 1100/2

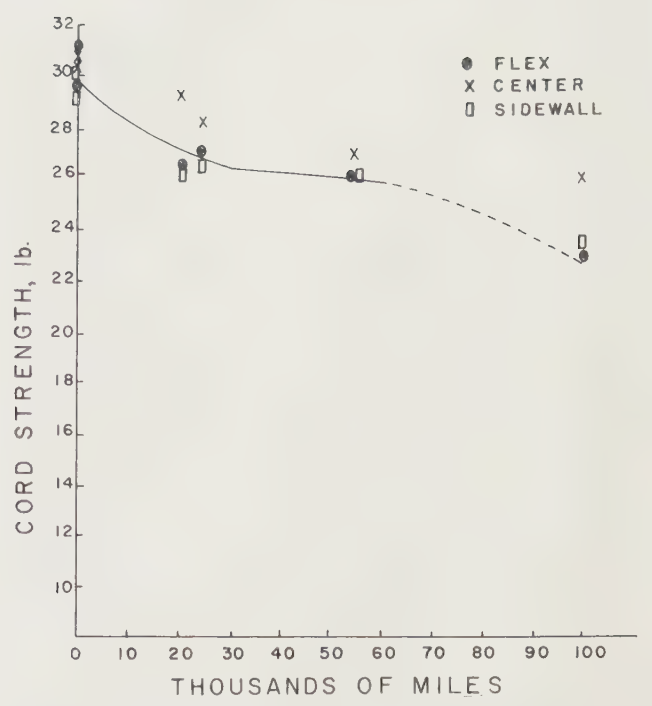


Fig. 5. Cord strength versus tire mileage; viscose A 1650/2

Flex—the center of the test specimen about $3^1/_2$ in. from the center of the cord, corresponding to the region of maximum flex-compression, a position about one third of the way from nos. 11 to 12 on Fig. 2.

Lower Sidewall—the center of the test specimen at about 6 in. from the center of the cord. This is close to where no. 9 appears on Fig. 2.

These tests were performed with whatever rubber remained on stripping the cord from the tire, still attached. The variability of cord breaking strength was extremely low and it was rarely necessary to make more than ten breaks to establish a sufficiently accurate estimate of the strength (±0.5 lb.).

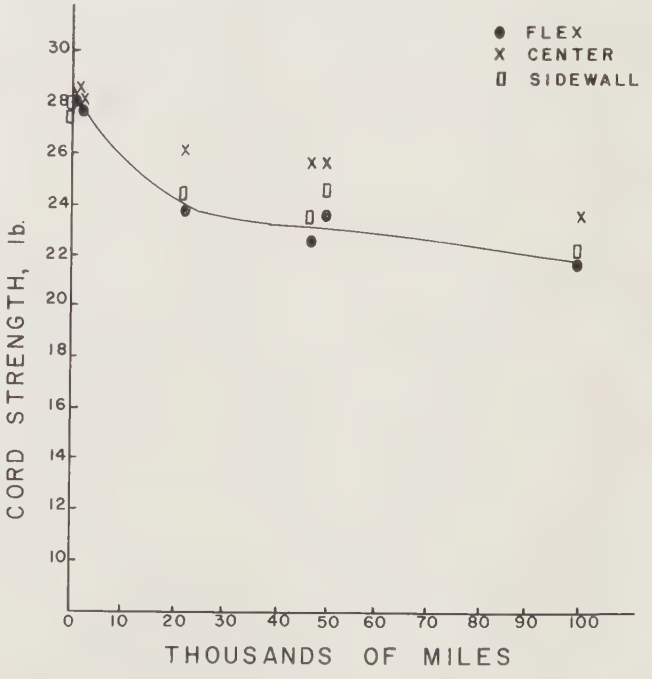


Fig. 6. Cord strength versus tire mileage; viscose B, 1650/2

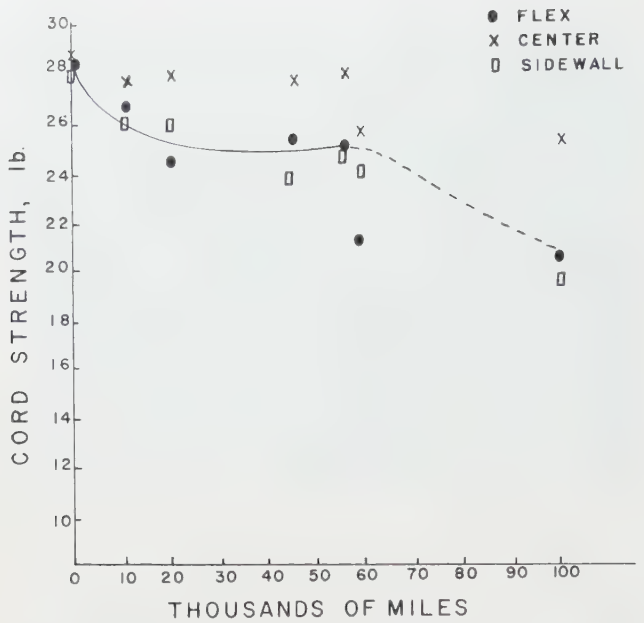


Fig. 7. Cord strength versus tire mileage; nylon, 840/2

Filament Strength and Elongation. The same three regions were considerd for filaments as for cords. The filament specimen length, however, was only 1 in. Filaments were removed from the cords in two ways: by partially slitting the rubber coating on $1^1/_2$ in. pieces of cord and carefully opening the cord by untwisting. Individual filaments could then be teased out; by chemically stripping the rubber from the cords, thus exposing all fibers to easy removal.

Sufficient statistical accuracy was usually established for any given point by the examination of 25 fibers.

All fibers were measured for denier on a vibroscope before tensile testing.

Cord Adhesion. To measure cord adhesion the carcass section was turned inside out and every other cord removed. The carcass was then placed on the lower cross-head of an Instron and one of the remaining cords, partially stripped, fastened in the upper jaw. As the cross-head moved down, the carcass was manipulated so as to keep the direction of cord pull normal to the carcass surface. In this manner stripping force was plotted as a function of position in the tire.

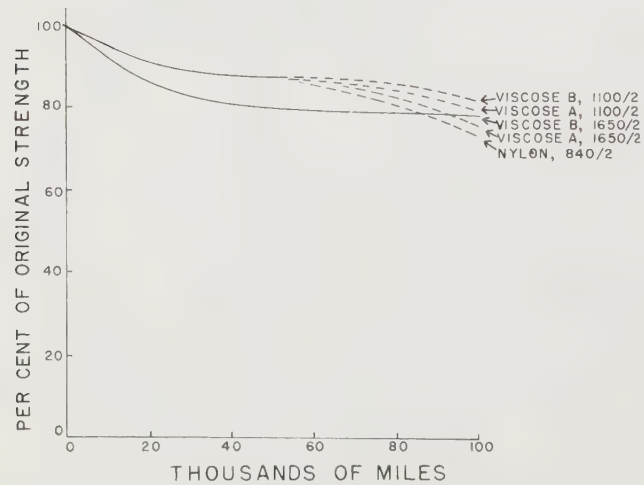


Fig. 8. Per cent residual cord strength versus tire mileage

Visual Evaluation. The physical appearance of the carcass and cords was noted at all stages of dissection. In addition, the cord structure was more closely examined on those from which all rubber had been chemically removed.

EXPERIMENTAL RESULTS

Cord Strength

Figures 3 through 7 show the breaking strength of cords removed from tires as a function of tire mileage. While the strengths for all three regions, flex, center or crown, and lower sidewall are given, the curves are drawn to represent the flex zone values only.

Note that for all types considered the trend is the same; an initial nominal drop in strength followed by a long period of essentially constant strength and, in some cases, a further small drop somewhere between 60,000

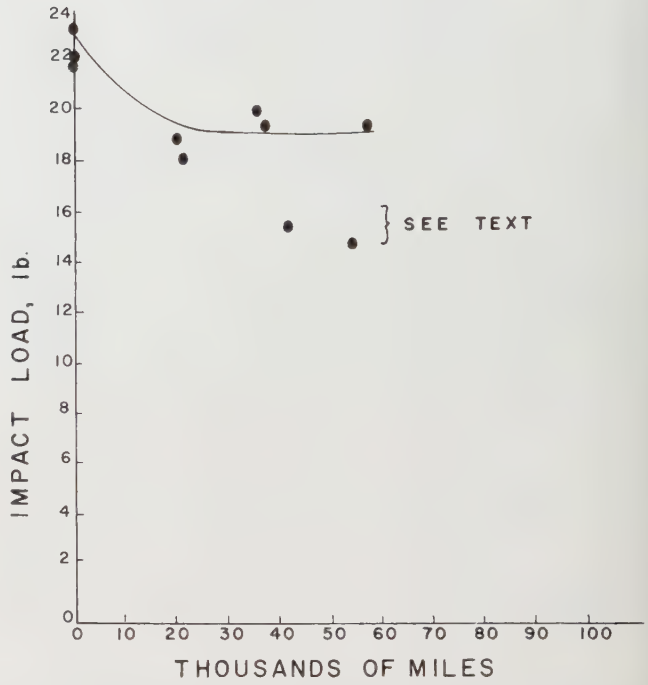


Fig. 9. Impact cord strength versus mileage; viscose B, 1100/2

and 100,000 miles. This latter drop cannot be very well defined, however, since no points were obtained between 60,000 and 100,000 miles and a single tire of each series was examined at 100,000. Nonetheless, the fact that all five showed a similar behavior suggests that the general level, if not the exact magnitude of the end points, is correct.

Three individual points on these curves deserve special comment. First, the two low points in Fig. 4. These were due to obvious physical damage to the cords and will be discussed further in the section on visual evaluation. Second, there is a low point at about 60,000 miles in Fig. 7, the nylon graph. The cause here was lowered fiber strength, and this will be amplified later in the general discussion of fiber properties. It is of interest that although the strength of the nylon cord remains quite high in the crown, or center region, its degradation rate in the flex zone is substantially the same as that of the Tyrex viscose cords.

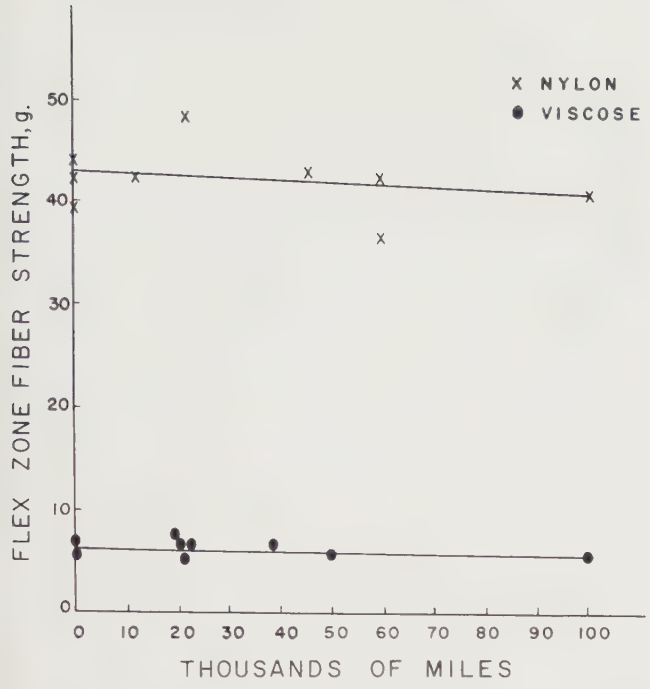


Fig. 10. Flex zone fiber strength versus tire mileage

Figure 8 presents a normalized composite of the curves from Figs. 2 to 7. Shown in this form, the quantitative similarity of the five becomes obvious.

In addition to the above low-speed tensile testing, a group of 1100/2 viscose B cords were evaluated under impact tensile loading conditions by American Enka Corp. using a previously published technique (*4*). The results are plotted in Fig. 9. While the impact strengths were higher than the static strengths, no differences in trend were noted with respect to mileage. While the cords were tested at full length, the break is always in the weakest, or flex zone. Thus a direct comparison can be made to the curve of Fig. 4, which is for the same type cord tested at low speed. Except

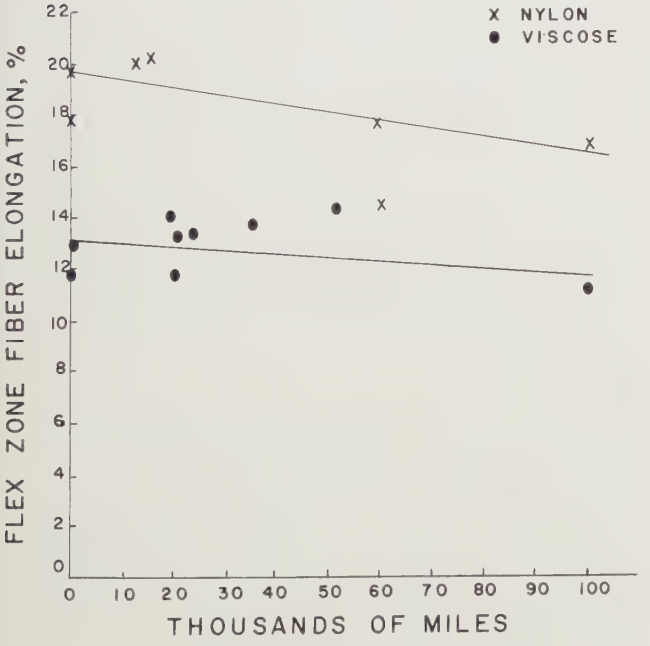


Fig. 11. Flex zone fiber elongation versus tire mileage

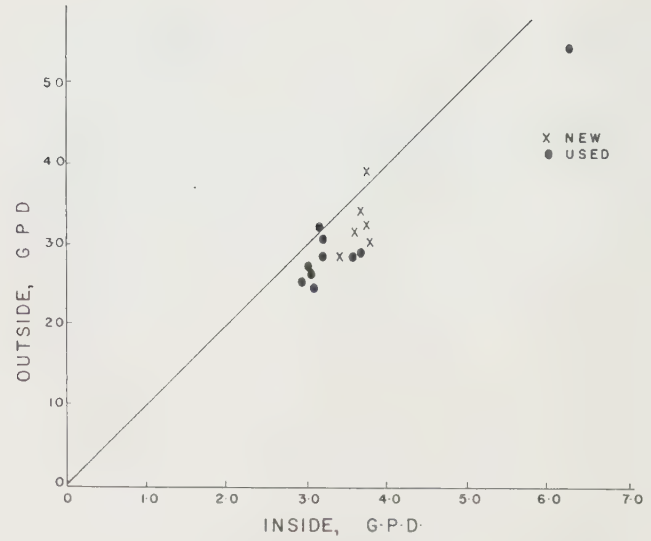


Fig. 12. Comparison of tenacity of fibers from inside and outside of cords

for the different level, the curves are very nearly identical, even the two aberrant weak points appearing at the same relative level.

Filament Strength and Elongation

Figure 10 shows the relationship between tire mileage and the strength of fibers removed from the flex zone of these tires. These fibers were removed from the cords by mechanical means only. Clearly, while there appears to be a slight degradation with mileage the amount is small, very much smaller than what would be necessary to account for cord strength losses. The sole exception is the low nylon value at 60,000 miles which corresponds to a similarly low cord strength (see Fig. 7).

The denier of the nylon filaments is about 6.0, and the Tyrex viscose, 1.6. Thus the absolute difference in strength level is no more than would be expected on the basis of the slightly higher tenacity of nylon.

Figure 11, filament rupture elongation versus mileage shows a similar slight trend toward decreased elongation

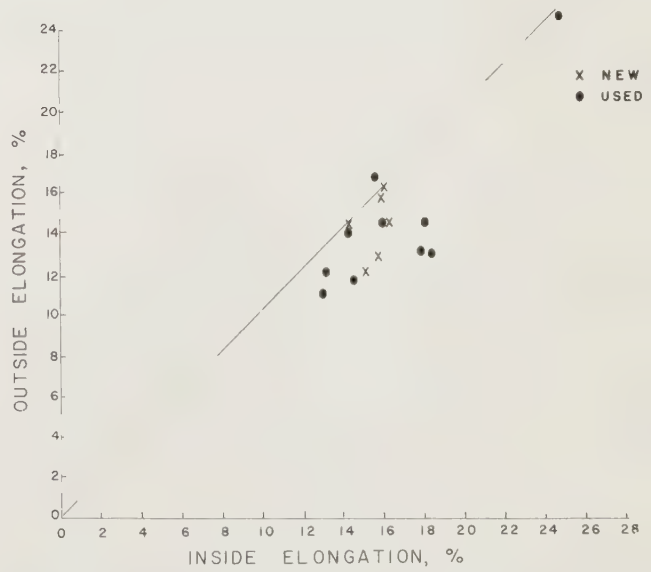


Fig. 13. Comparison of elongation of fibers from inside and outside of cords

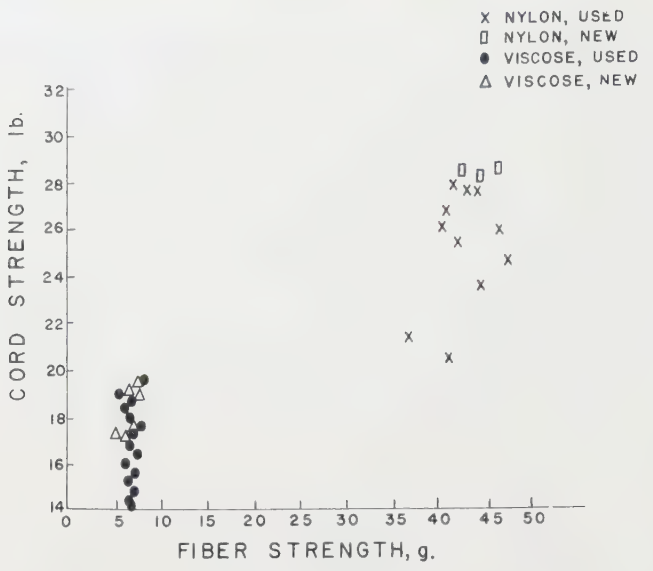


Fig. 11. Fiber strength versus cord strength

However, the data are rather scattered and one could hardly attach much significance to the change.

There is always the possibility in a biased sampling of this sort, wherein fibers on the outside of cords could not be tested, that significant errors in interpretation might be made. To obviate this possibility, fibers from chemically stripped cords were tested and the tensile properties of the outside fibers, previously imbedded in rubber, compared to those from the inside of the cord. The treatment itself caused a slight shrinkage and degradation of tensile properties so no comparison is made to mechanically removed fibers.

Figure 12 is a plot of the tenacity of the inside versus the outside fibers from the same cords. The line drawn is not through the points but is rather an equal tenacity reference. If there were no difference between the two regions the points would be scattered randomly about this line. The fact that there is a strong tendency for the points to aggregate below the reference shows that the outside fibers were definitely weaker. The important point, however, is not that the outside is weaker, but that the same tendency is manifest for both new tires, indicated by X's, and used tires, shown by circles. Thus it must be concluded that the strength differential

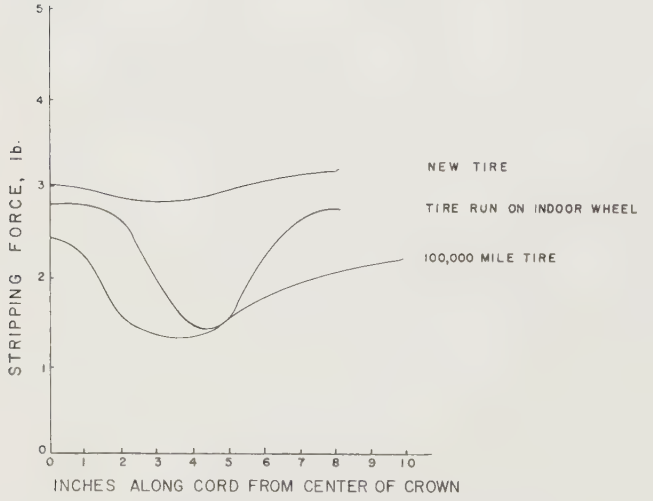


Fig. 15. Cord stripping force versus cord position as influenced by tire mileage

is due to factors other than use, most probably either processing or rubber removal.

Figure 13 is similar to Fig. 12 but shows the rupture elongation relationship between inside and outside fibers. The same sort of conclusions apply here as for Fig. 12.

Having established the validity of using the inside fibers as a reference, it is reasonable to examine the relationship between the tensile strength of mechanically removed inside fibers and the strength of cords similar to those from which they came. It might be supposed that this relationship would show less scatter and more correlation than either of the individual plots versus mileage. Figure 14 shows that this is not the case and the major cause of cord strength loss does not reside in a loss of fiber strength.

In addition to the above tensile investigations some work was done using x-ray techniques to evaluate

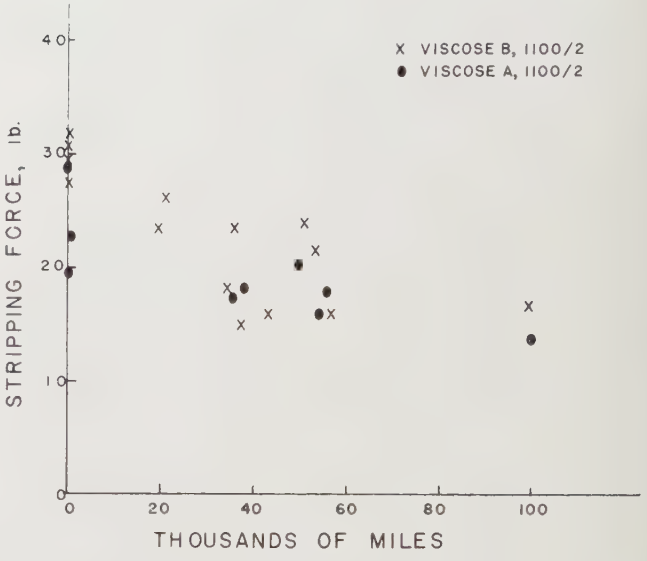


Fig. 16. Flex zone cord stripping force versus mileage

changes in fine structure. This work was done by Kraessig and Kitchen of Industrial Cellulose Research Ltd. using a technique soon to be published. The parameter studied was lateral order factor ($F_{L.O.}$), which for samples of the same degree of polymerization has been found to be linearly related to tensile strength. The results obtained are shown in Table II.

Within the limits of fiber variability and experimental error, the data in this table can be considered supporting evidence to the tensile test findings above wherein there was shown a slight tendency to fiber strength loss with mileage. The assumption of the same degree of polymerization is currently being checked.

Cord Adhesion

It is generally accepted that adhesion of cords to the rubber somehow plays an important part in the fatigue life of the cords. A gross picture of adhesion can be obtained by the method described previously. The general levels of adhesion (as measured by the stripping test) are shown in Fig. 15. The new tire and 100,000 mile tire are from the viscose A, 1100/2 series while the indoor wheel plot is a typical curve taken from the work of Entwistle (*2*). Note that the highest loss of bonding

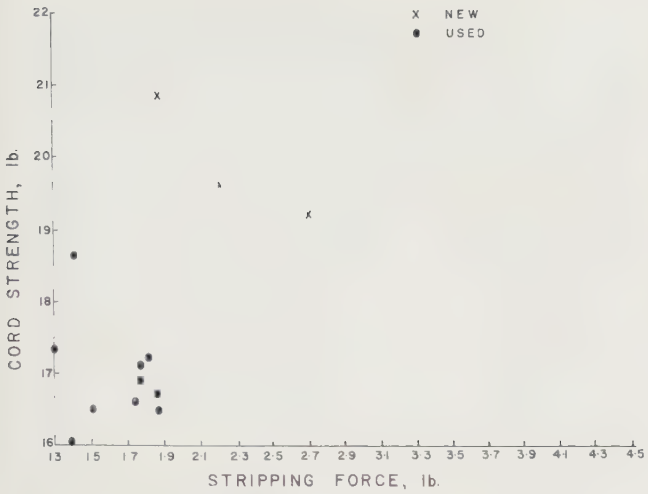


Fig. 17. Cord strength versus stripping force; viscose A, 1100/2

force occurs in the region of maximum flex (between $3^1/_2$ and 4 in. along the cord from the center of the tire). The trend is the same for both wheel and fleet tested tires but it was observed by Entwistle that the effect was less consistent on fleet tested tires. This lack of consistency can be seen in Fig. 16, where the flex zone stripping force is plotted against tire mileage for a number of 1100/2 cord tires. The trend toward lower adhesion is definite, but the variability is large.

Figures 17 and 18 show very little correlation between stripping force and cord strength. This is not to say that adhesion and cord strength are unrelated, but simply that the gross nature of the test and the high variability of the data do not permit such a relationship, even if true, to be established. It is also circumstantial evidence suggesting that adhesion breakdown is significant only when relatively complete, thus leading to the so-called catastrophic failure.

Visual Evaluation

In the course of tire and cord dissection a number of qualitatively important observations were made:

1. After removal of the inner layer of rubber, small, discrete cracks were sometimes evidenced in the thin layer still remaining over the cords. Such regions were invariably associated with severe strength loss in the cords beneath.

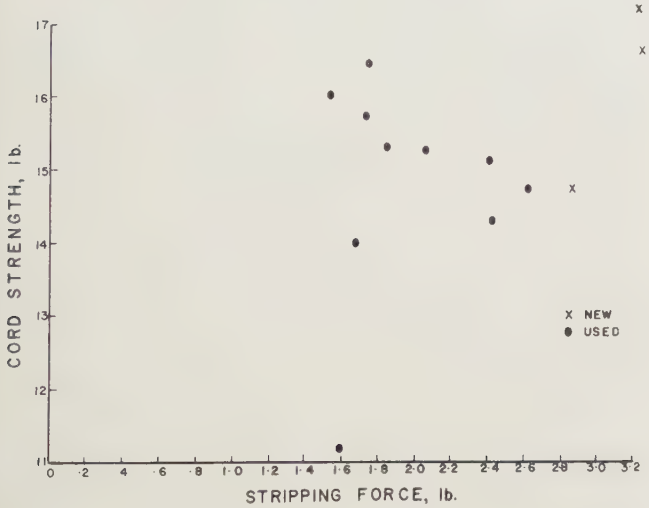


Fig. 18. Cord strength versus stripping force; viscose B, 1100/2

Fig. 19. Viscose cord showing damaged flex zone

2. Chemical removal of rubber from such cords showed excessive local fiber breakage, the extent of which was approximately that required to account for the excessive cord strength loss.

3. Such damage, when it occurred, was always at a filling yarn crossover and at the helical line of singles yarn contact in the cord. A typical damaged cord is shown in Fig. 19. This particular cord is representative of those giving the low values at 42,000 and 54,000 miles in Figs. 4 and 9. Since this type of damage followed the circumferential flex line quite uniformly, it is suspected that the damage was due to some period of underinflation.

Tires Classified as Fatigue Failures

Four tires additional to those already discussed were diagnosed symptomatically as fatigue failures, that is they exhibited the characterisitc circumferential breaks in the flex zone. Cords from all and filaments from two were examined in the same manner as for the tires previously discussed herein. The results are given in Table III.

For the fatigue-failed tires, strengths of cords in the flex zone were determined (1) for cords adjacent to the failure, and (2) for cords far removed from the failure. Where two values are given in Table III the lower one pertains to those cords adjacent to the failure region. Where only a single value is given, no dependence on location was found.

TABLE II

Cord	*Tire mileage*	$F_{L.O.}$[a]
Viscose B, 1100/2	0	4.75
Viscose B, 1100/2	57,000	4.75
Viscose B, 1100/2	100,000	4.0

[a] $F_{L.O.}$ = Lateral order factor.

Note that in the case of the two failed Tyrex viscose tires, cord and filament strengths are no different than those found for unfailed tires at the same mileage, viz., Fig. 6. No large reduction in cord strength has been observed. Observation of the cords from the Tyrex viscose tires when stripped of rubber indicated only mild filament breakage, occurring exclusively at the filling crossovers.

Figure 20 shows a chemically stripped viscose cord replaced in its original position on the inner surface of the carcass. Note the multiple areas of filament breakage, each occurring at a filling crossover. This region is centered in the flex zone. The tire from which this picture was made failed in fatigue. It did not come from the taxi fleet test but is shown because it is an extreme example of the type of damage described above.

Table III

Code	Cord	Mileage at failure	Cord strength, lb. Crown	Flex	Sidewall	Filament strength, g. Flex zone
Viscose B	1650/2	50,066	27	24	25	
Viscose B	1650/2	48,498	23	22, 23	24	6.3 (1.6 denier)
Viscose B	1650/2	0 (Control)		27.5		6.5
Nylon	840/2	59,469	28	23	25	
Nylon	840/2	52,356	27	14, 23	24	27.4 (6.0 denier)
Nylon	840/2	0 (Control)		28.0		44.0

For the failed nylon tires, substantial reduction in cord and filament strength was observed only in the case of the 52,356-mile tire, in the flex zone adjacent to the region of failure. For this tire, filament strengths

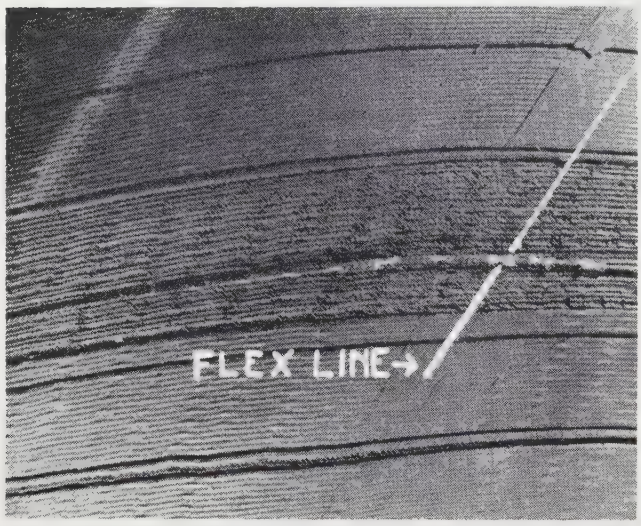


Fig. 20. Viscose cord showing multiple damaged areas at filling crossovers

were also drastically reduced, a loss of about 40% being found in contrast with a loss of about 50% in cord strength. Additional losses resulting from some fiber breakage may be present in this nylon cord, but such breakage has not yet been observed.

DISCUSSION

Several important facts have been established with respect to cords and filaments from the taxi fleet test. It would be of interest now to enumerate these and evaluate their general significance in the light of the work of Williams and Entwistle (*1*, *2*) which were done under different conditions.

1. The problem of fatigue has not manifested itself as a consistent degradation of cord tensile properties. In no case has there been either a failure or an appreciable weakening of cord strength which could be associated with a continuous degradation. Even in fatigue failed tires, cords adjacent to the failure were in general of normal strength. Thus it is concluded that the cord fatigue process, once initiated, runs a rapid course to failure.

Entwistle, on the basis of both indoor wheel- and fleet-tested tires (overloaded and underinflated in both cases), concludes that "-fatigue failure in a tire is often a catastrophic process during which cord strength rapidly falls to zero but which is not preceded by significant and progressive loss of strength." Williams, however, states that fatigue failure stems from progressive loss of cord strength in the flex zone. This work, like Entwistle's, was done on overloaded and underinflated tires.

2. We have shown that after an initial, relatively rapid loss of cord strength there follows a long period in which the rate of loss is very small.

Entwistle, though his mileage scale was compressed due to the accelerating action of overloading and underinflation, states substantially the same thing. Williams differs here, and concludes from his work that the loss in cord strength is linear with mileage. The cause of the initial loss is as yet unexplained.

3. Fiber tensile properties degrade at a very low rate; large losses in cord strength are attributable to fiber breakage at discrete points. Here there is complete agreement among the three investigations.

In two isolated cases, both nylon, significant loss of fiber tensile strength and rupture elongation was found. The reason for this has not been established.

4. Fiber breakage appears to occur primarily in the flex zone and at filling yarn crossovers. It seems to follow the helical line of contact between the two singles in the cord. Williams is not so explicit but is in general agreement. Entwistle likewise agrees. Neither mentions any observation on the role of the filling yarns.

5. Significant local rubber damage (cord-rubber separation), not shown by the stripping test, but rather by visual observation, appears to accompany large cord damage.

Williams does not consider adhesion. Entwistle, on the other hand, has considered localized bond failure quite extensively with respect to both indoor wheel and fleet tested tires. Our observations are in general agreement with his, which are much more extensive than our own. Apparently, local bond failure gives rise to excessive local fiber strains leading to early failure.

The only real lack of agreement in all of the work discussed comes from Williams' contentions that (a) loss in cord strength is linear with mileage and (b) that this loss progresses to an ultimate fatigue failure. It is our feeling that this discrepancy is due not to a fundamentally different phenomenon or a difference in techniques, but rather to the interpretation of the data. Williams' conclusions are based on two plots, one containing three points, the other, two. In the case of the three point plot the locus is apparently linear, but considering the small differences in strength shown by these points and a normally anticipated variability, characterization of a linear relationship is questionable. Clearly, a straight line can be drawn through the two points of his other plot, but no functional relationship can be established from this. Once having agreed that a progressive linear loss does not exist, the assumption that such a loss leads to fatigue failure is obviously no longer tenable.

In conclusion, it seems apparent that in general cords do not become progressively weaker until failure, but rather fail suddenly; that the failure is not associated with a degradation of fiber tensile properties; and that localized bond failure is frequently if not always associated with such cord failure.

For the tires studied it is not possible to establish differences between Tyrex viscose and nylon in fatigue since the number of failures was small, and all occurred at high mileages. Similarly, rates of degradation of tensile strength of cords containing either fiber type could not be distinguished from each other.

LITERATURE CITED

1. Williams, Hannel, and Swanson, *Ind. Eng. Chem.* 45: 796 (1953).
2. Entwistle, Jones, and Pittman. "Recent Advances in Tyre Yarns." Printed by Courtaulds, Coventry (Dec., 1958).
3. Breazeale, *ASME Paper* No.: 59-SA-52.
4. Parker and Kemic, Technical Symposium on Rayon Tire Yarn Progress; Akron, Ohio (Jan. 23, 1958).

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

This work has been jointly sponsored by the following Tyrex viscose tire yarn and pulp producers: American Viscose Corp., American Enka Corp., Buckeye Cellulose Corp., Courtaulds (Canada), Ltd., Industrial Cellulose Research, Ltd., Industrial Rayon Corp., North American Rayon Corp., Rayonier, Inc.

A Measure of Surface Tension and Surface Film Elongation

P. B. DAVIDSON

With the use of the Instron tester, it was possible to obtain not only a measure of surface tension but also a measure of force-ring displacement or surface-film elongation of animal glue dispersions. The latter property was found to be influenced by protein disintegration products, zinc salts that were added as a preservative, and by defoaming agents. The conditions for the test method are described as they apply to the testing of animal glue dispersions. A foaming test for such systems is also described.

For many years the purchase of animal glue for tub sizing of paper has been based upon specifications of gel strength and viscosity. With more stringent demands being placed upon the properties of technical papers it became rather obvious that these specifications for animal glue did not tell us all that we should now know about its behavior as a tub-sizing material. These misgivings prompted an investigation of other possible glue testing methods that would serve as criteria for tub-sizing efficiency.

One of the glue properties under investigation was that of adhesion tension which required the determination of contact angles and surface tension. It was learned that Victor Jackman, of the Instruments Section at Mellon Institute, had developed a surface-tension method using the Instron tester. This method had the advantages of sensitivity, known and uniform rates of applying stress, and a stress-ring displacement curve was obtained charting the history of the determination. Using some refinements of the method developed by J. T. Seawell of the Institute's Corn Products Fellowship, very interesting and useful information was obtained concerning various animal glues.

P. B. Davidson, Senior Fellow Mellon Institute, Pittsburgh, Pa.

In this method, the test sample was placed on the bottom platen of the tester. The platinum ring, of the type used with the DuNouy instrument, was attached to a long thin rod and clamped in the upper jaws of the tester so that the ring was below the surface of the sample. As the platen was lowered at a rate of 0.2 in. per min. and the ring reached the surface of the sample, the pen on the automatic recorder traced a force-ring displacement curve. The chart was run at a speed of 5 in. per min. which allowed a sharp maximum to be recorded. From this maximum point was calculated the surface tension. Each scale division on the chart represented 0.2 g. and, knowing the circumference of the ring, the approximate surface tension was calculated from the formula:

$$\gamma = \frac{Mg}{2L}$$

where

M = grams.
g = 980.3 cm. per sec.^{2}
L = ring circumference, cm.

There are numerous methods for measuring surface tension, such as the capillary-rise and drop-weight methods, but the Jackman method gives a measure of not only surface tension but of the elasticity or elongation of the surface film. It was this latter measurement that gave new and valuable information about animal glue dispersions. This fact is illustrated by the flat-dome shaped curves of Figs. 1 and 2.

It will be seen that after the maximum was reached the curve trailed off with gradually decreasing stress

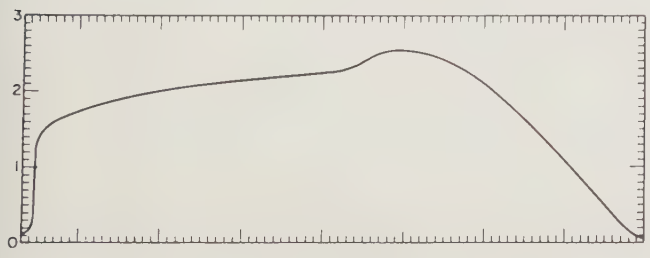


Fig. 1. Glue sample A
pH 6.98; Temp. 46°C.

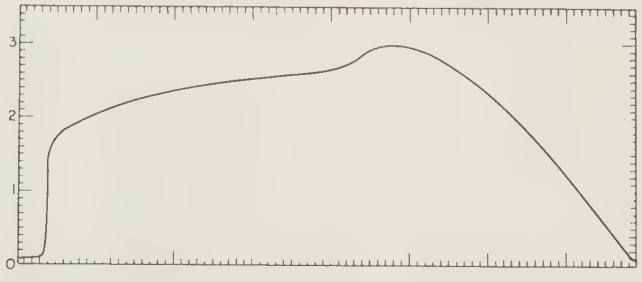


Fig. 2. Glue sample A
pH 9.03; Temp. 46°C.

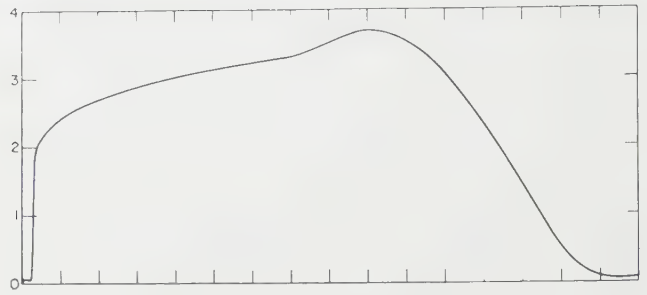


Fig. 3. 7% glue
pH 7; Temp. 45°C.

until the ring finally broke free from the surface. Knowing the chart speed to be 5 in. per min., the ring speed 0.2 in. per min., and that 10 small chart divisions equaled 1 in., one chart division was equal to 0.2 in./50, or 0.004 in. of ring-travel distance or surface-film elongation of the glue sol.

It was obvious that slower chart speeds condensed the curves to such short distances from the maximum to the break-off point that critical differences in surface-film elongation could not be measured. Increasing the chart speed appreciably above 5 in. per min. flattened out the maximum on the curve so that errors in measuring the ring-travel distance were increased.

In the glue-testing program attempts were made to study glue properties under the conditions in which the glue was used in the size press. If a seven or eight % glue size is applied at 45°C., it appeared unrealistic to test the glue at 1 or 2% and at room temperature. Glues of 7% concentration had to be tested at 45°C., or above the transition temperature. Testing 7% glue sols at 45°C. in an open vessel introduced some complications. In testing some other types of dispersions at elevated temperatures Mr. Seawell placed the test sample in a three-neck, round-bottom flask of such size that the meniscus at the side of the container did not interfere with the meniscus created by the surface tension ring. The ring was lowered through the center neck of the flask, a thermometer was inserted in one of the side necks and a stopper in the other. A practically moisture-saturated atmosphere was thus obtained above the sample which reduced to a minimum the tendency to form a partially dried skin on the surface. With the use of a Glas-Col heater the temperature of the dispersion could be satisfactorily controlled.

At a later date Mr. Jackman designed and built a portable surface-tension instrument which gave the same information obtained with the Instron tester. A description of this instrument has been submitted to *Analytical Chemistry*. If the temperature is measured with a thermocouple and the instrument is hooked up to a two-pen recorder, curves for both surface-film elongation and temperature of the sample can be obtained on the same chart.

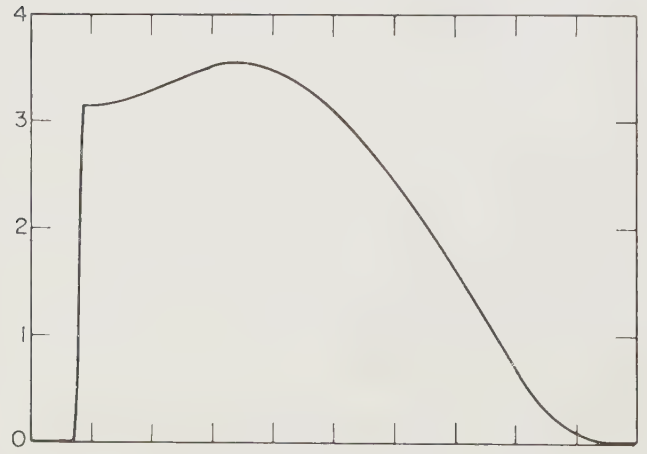


Fig. 4. 5% glue
pH 7; Temp. 47°C.

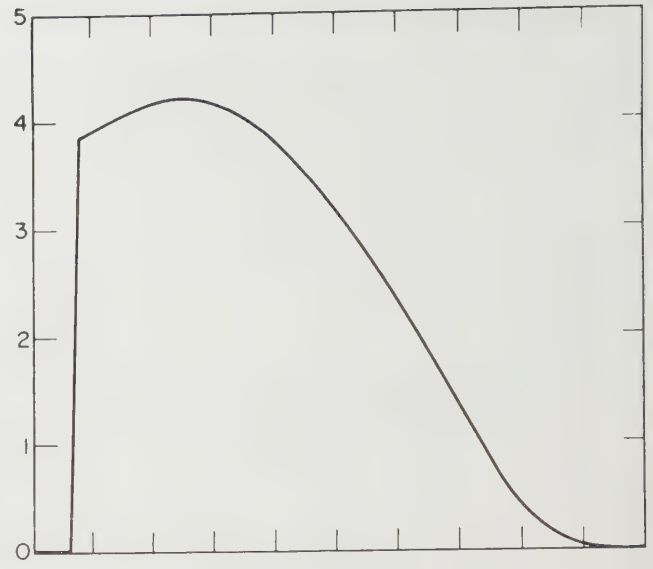


Fig. 5. 2% glue
pH 7; Temp. 47°C.

Ring travel, in.	*Surface tension, dynes*
0.0396	34.4
0.1403	32.7
0.0736	32.6
0.0495	29.8

As was stated earlier, the glue dispersions were tested at 7.7% concentration. Some of the glues were tested at 5 and 2% concentrations. Figure 3 shows the surface property curve for the 7% glue sol at pH 6.98. This glue has proved to be of good quality and produced satisfactory sizing in blueprint paper. Figure 4 shows the curve for a 5% dispersion, and Fig. 5 at 2% concentration. It appears from these curves that measuring the property of surface-film elongation should be done at the higher glue concentration of about 7%.

In making these determinations, at least two curves were obtained for each glue sample under one set of conditions. With a satisfactory glue these curves were identical, within small experimental error. However, some glues were tested that gave a group of widely different curves. In other instances glues gave duplicate curves showing a long ring-travel distance of pH 7 but at pH 9 short ring-travel distances. It was found from experience that a glue giving a group of erratic curves performed just as erratically as a tub-sizing material. One such glue gave ring-travel distances from curves obtained successively with the same sample within a testing time of about 15 min. of 0.0396, 0.1403, 0.0736, and 0.0495 (Table I). The surface-tension measurements did not follow parallel to the elongation but were, respectively, 34.4, 32.7, 32.6, and 29.8.

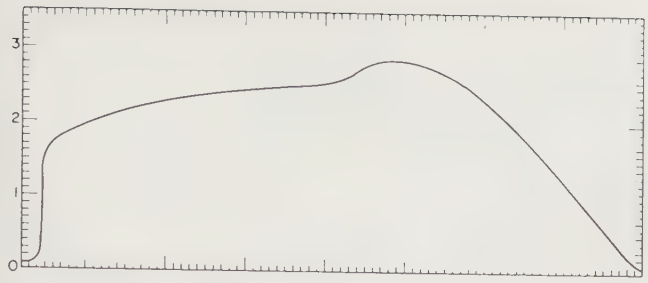


Fig. 6. Glue sample D
pH 7.02; Temp. 46°C.

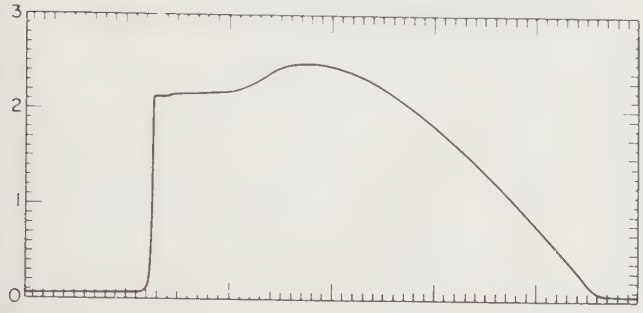


Fig. 7. Glue sample D
pH 8.99; Temp. 46°C.

The glues that consistantly gave "bob-tailed" curves at pH 9 or at both pH 7 and pH 9, required further investigation. Sample D, a 380-g. glue (Figs. 6 and 7), gave curves practically identical to those for sample H, a 315-g. glue. Both glues possessed good elongation at pH 7 but poor elongation at pH 9.

It was found that such "bob-tailed" curves at pH 9 were typical of glues to which zinc salts had been added as a preservative. Figure 8 shows the curve for another high gram-strength glue (279 g.) but which gave bob-tailed curve at pH 7, and Fig. 9 shows the same type of curve at pH 9. This glue contained not only a critical amount of zinc but also three disintegration products, as determined by a chromatographic analysis.

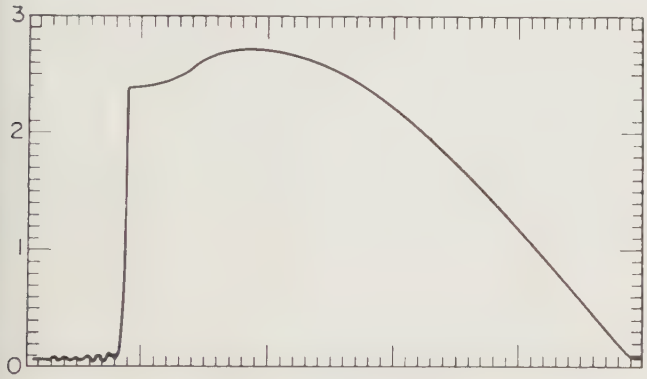


Fig. 8. Glue sample F
pH 6.99; Temp. 46°C.

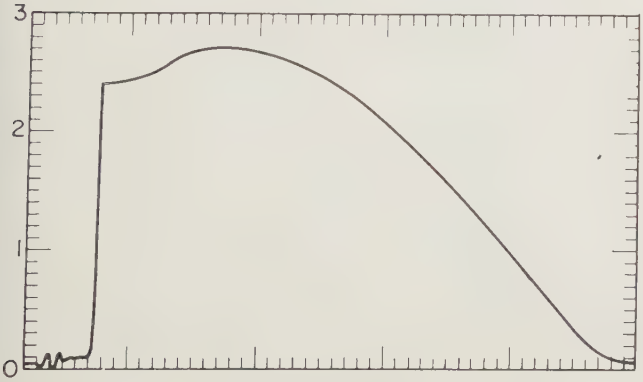


Fig. 9. Glue sample F
pH 9.0; Temp. 47.5°C.

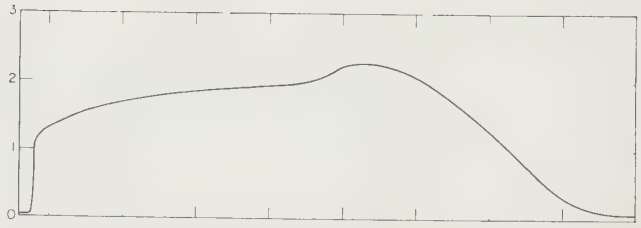


Fig. 10. Glue sample 589
pH 7; Temp. 44°C.

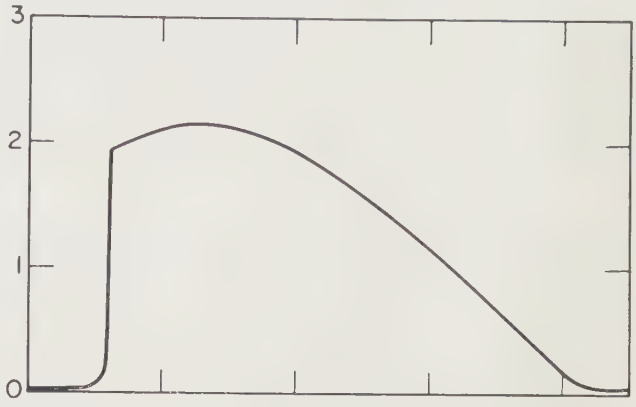


Fig. 11. Glue sample 589-2 + defoamer
pH 7; Temp. 43.5°C.

Defoamers also caused a reduction in surface elongation. Figure 10 shows the curve for a glue at pH 7 which foamed excessively over 500 ml.

Figure 11 shows the effect of adding 0.1% of a non-ionic defoamer to the glue dispersion which reduced the foam to 23 ml.

The foaming test consisted of bubbling air at 125 ml. per min. through an orifice of 0.4 mm. i.d. into a 50-ml. sample of glue size for 15 min. The glue sample was contained in a 500-ml. graduated cylinder placed in a constant-temperature bath and kept at 45°C. for 2 hr. before the foaming test was started. It was found that this 2-hr. aging period at the temperature of the test was essential for reproducible results. Except in extreme cases of excessive foaming this test measured an equilibrium condition in which the rate of foam formation was equal to the rate at which the foam broke, or, in other words, foam stability. The correlation of surface-film elongation with foam stability is what might be expected. A stable foam depends upon a tough, elastic surface film and the Jackman instrument gives a measure of such properties. This same correlation has been observed by those working in entirely different fields, such as foamed plastics and sugar solutions.

We do not wish to imply that the Jackman-Seawell method of measuring surface tension and surface-film elongation is a substitute for gel strength and viscosity determinations in the evaluation of animal glues, but it does serve as one of several tests which have been found necessary for the proper evaluation of glues for tub sizing of paper.

Received Mar. 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Rapid Melting-Point Method for Waxes

DONALD C. WALKER

An apparatus has been devised for quickly and accurately determining the melting point of a small amount of wax. A thermocouple measures the temperature of one drop of wax, and the cooling curve is automatically recorded. The method is useful with a wider variety of waxes than the ASTM cooling-curve method, yet has nearly the same precision and requires much less time.

Melting point is one of the most commonly determined physical properties of petroleum wax. There are no published methods, however, for quickly and accurately determining the melting point of a small amount of wax. Such a method is needed when time is short or when little of the wax is available.

Several micromethods (*2, 3, 4*) quickly determine the approximate melting or freezing point of waxes. Capillary-tube and block techniques for melting point are accurate for pure compounds but not for waxes; drop-point or thermometer-bulb methods for freezing point are easy to run but the results are variable. Accurate and reproducible results are obtained with the ASTM cooling-curve method (*1*), but it requires about 25 g. of wax and at least an hour for a single determination. Some motor-oil and microcrystalline waxes cannot be determined because the curves show no plateaus at the freezing point.

A new method has been devised that has the accuracy of the ASTM method plus the simplicity and speed of the micromethods. The temperature of one drop of wax is measured with a small thermocouple, and the cooling curve is automatically recorded.

The apparatus consists of a thermocouple unit with a temperature recorder and a heating sleeve. Details of the thermocouple are shown in Fig. 1. The wires are coiled in a spiral so that the thermocouple junction is in the center; they must not touch, yet must be close enough so surface tension will hold the wax in the coil.

Donald C. Walker, Research and Development Department, Standard Oil Co. (Indiana), Whiting, Ind.

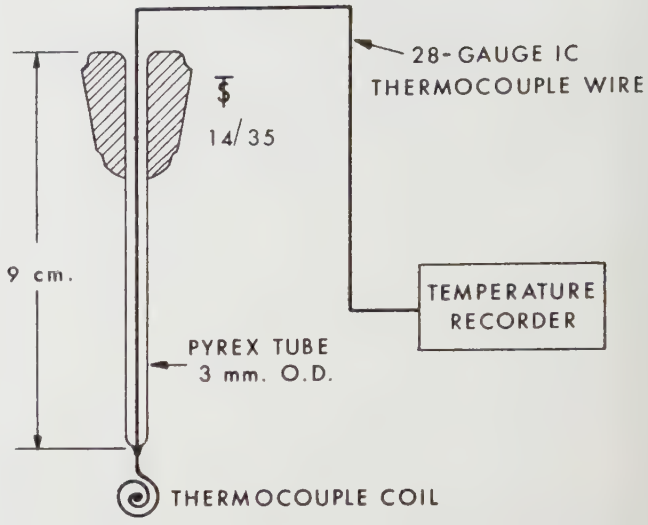


Fig. 2. Thermocouple unit

The thermocouple support and temperature recorder are shown in Fig. 2. The thermocouple is calibrated with several waxes having ASTM melting points of 110 to 170°F. Melting points are plotted against chart readings of the temperature recorder to give a linear calibration curve. The recorder is continuous and has automatic balancing; the resistance is adjusted for a range of 100 to 200°F. The strip chart has 0.5°F. divisions and a speed of 24 in. per hr.

The heating sleeve shown in Fig. 3 is used to melt the wax and to control the temperature during cooling. Additional resistance for the circuit is provided by a 60-w. lamp, which also serves as a warning light. The

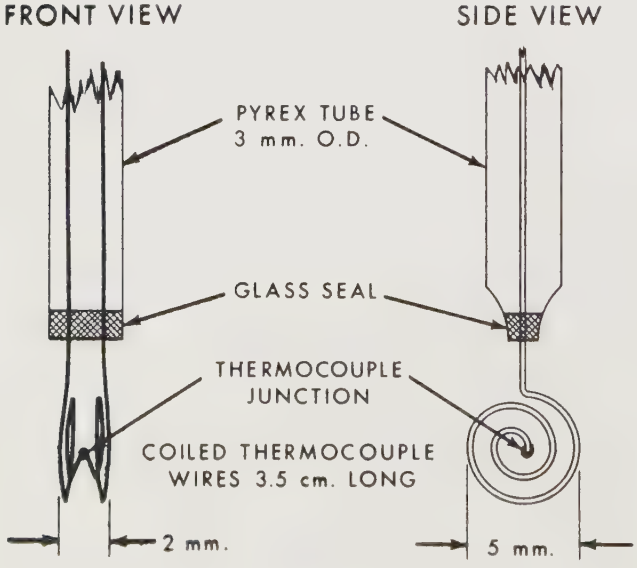


Fig. 1. Thermocouple coil

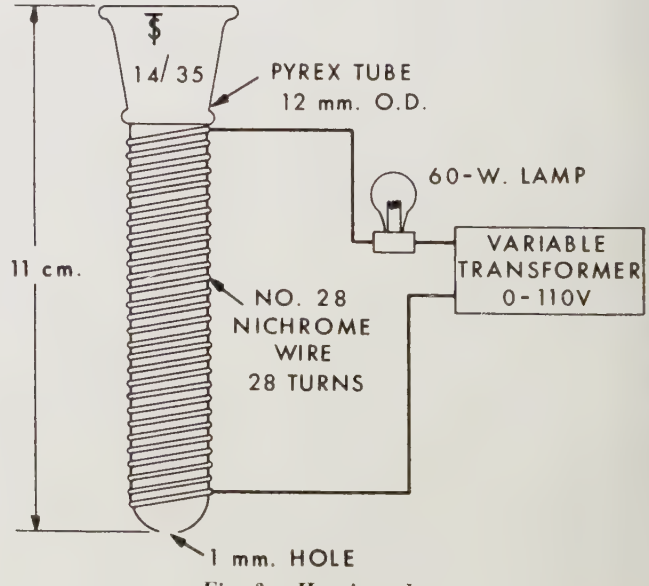


Fig. 3. Heating sleeve

Table I. Melting Points of Petroleum Waxes, °F.

ASTM method	This method
Paraffin Waxes	
110.8, 110.8	110.7, 110.8
128.5, 128.5	128.6, 128.4
137.7, 137.7	137.8, 137.6
143.2, 143.2	143.4, 143.3
171.7, 171.6	171.8, 171.9
Motor-Oil Waxes	
146.4, 146.4	146.4, 146.4
[a]	146.7, 146.4
Blends	
137.8, 137.8	137.8, 138.0
140.2, 140.2	140.4, 140.4
Microcrystalline Waxes	
[a]	169.0, 169.0

[a] No plateau in cooling curve.

temperature of the thermocouple in the sleeve is determined for various settings of the variable transformer.

One drop (20 to 60 mg.) of the melted wax is applied to the side of the thermocouple coil, and the coil is placed in the heating sleeve. The transformer is adjusted to give a temperature of 180 to 200°F., and the temperature is observed when the wax remelts. When the wax is 20 to 30° above its melting point, the transformer is readjusted to give a sleeve temperature about 10° below the melting point. The resulting cooling curve shows a sharp plateau at the freezing point. After the test, the wax is removed by dipping the coil in hot solvent. About 5 min. is required for each determination.

This method has been used to determine the melting points of paraffin waxes, motor-oil waxes, blends of paraffin and motor-oil waxes, and microcrystalline waxes. The results in Table I show that it is almost as precise as the ASTM method; average deviation is only 0.1°F., and maximum deviation is 0.2°F. Melting points of many motor-oil and microcrystalline waxes can be determined, even though no plateaus occur in the slow-cooling ASTM method.

LITERATURE CITED

1. American Society for Testing Materials, "ASTM Standards on Petroleum Products and Lubricants," Philadelphia, Pa., D87-57, p. 16, 1957.
2. Marshall, A. W., *Anal. Chem.* 22, 842 (1950).
3. Warth, A. H., "The Chemistry and Technology of Waxes," Reinhold Pub. Co., New York, N. Y., 2nd ed., 1956, p. 602.
4. Weissberger, A., "Technique of Organic Chemistry," Interscience Pub. Inc., New York, N. Y., 1954, Vol. VI, p. 145.

Received Jan. 14, 1960. Presented at the 44th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 23–26, 1959.

Water Conservation by External Re-Use

L. L. KLINGER

Paralleling pollution abatement, the adaptation of water conservation by external re-use has become increasingly popular, as well as necessary, by the paper and paperboard industry. Toleration of recirculation and containment reaches a limit above which process water must be discharged from the mill to the stream or be specially treated for further use. As part of the 1960 Symposium of Water Practices Other Than Softening, by the TAPPI Water Committee, this paper reviews practicable methods of handling discharge process waters for their re-use. Reduction of pollution, savings in heat, and reclamation of solids and clarified water are economically feasible.

The paper and paperboard industry has become acutely conscious of waste water problems because of the necessity of pollution abatement. In the last decade bibliographies dealing with waste treatment in this industry as well as others requiring water for transportation of process materials has become voluminous. One need only to examine our own Bibliographic Series to fit himself into a history of his own peculiar problems.

PRIMARY TREATMENT

Primary treatment deals with the concentration of fibrous and inorganic waste matter to facilitate its removal from the combined waste waters discharged from the mill process. Dependent upon the quality of this waste matter either it can be returned to the process or discarded.

The clarified effluent can be re-used or discharged as determined by its quality and heat value. In critical fresh water areas, many times a compromise between quality and expediency results in much more extensive external re-use of process water.

Primary treatment can be classified in the following broad areas:

Subsistence or Ponding. The principle of ponding is to settle solids by adequate detention and quiescence, and allow an overflow of clarified supernatant to the receiving stream. Subject to the putrescible state of the waste and the population density, this type of treatment varies from completely unsuccessful to moderately successful.

Coagulation. The advances in the science and engineering of cold process water coagulation and clarification and the valuable information gained from the coagulation of sewage have been extended to include the coagulation and clarification of industrial wastes. The popularity of upflow clarifiers has been increasing rapidly. By the judicious control of influent wastes to these high rate units and metered control of chemical feeding devices, high efficiency in recovery of solids and clarity of effluent water has resulted. Considerable reduction in space and cost can be achieved by the employment of these high rate units.

Filtration. Diatomaceous earth in conjunction with

L. L. Klinger, Technical Assistant to the President, Whippany Paper Board Co., Inc., Whippany, N. J.

plate and frame filters, or batch leaf filters, has been used particularly in the paperboard industry. Recovery of fiber and filler in the filter and utilization of clarified filtrate is being accomplished. It can be expected that the field of filtration, both continuous and batch, will advance and provide answers for particular problems.

Flotation. Flotation of solids and removal of clarified subnatants with flotation savealls is considered more commonly with internal re-use of white waters in the mill. However, many such savealls have been installed to handle general discharge waters. Advances in the science of the handling of air in this process are likely to produce results intermediate between primary clarification and secondary biological treatment.

SECONDARY TREATMENT

In recent years, the nomenclature of sanitary waste treatment has been broadened to include industrial wastes such as in the paper and paperboard industry. Secondary treatment generally refers to the reduction of organic contamination to the flowing stream by biological processes.

The National Council for Stream Improvement has been instrumental in the promotion of secondary treatment in the field of paper and paperboard. A composite review by Gehm (*5*), of this Council, on pulp, paper, and paperboard wastes is invaluable as a general reference source for this industry. Because of the recognition of the importance of sanitary wastes in the pulp, paper, and paperboard industry, the Engineering Committee of TAPPI recently has added to it the Sanitary Engineering Subcommittee. This committee and the TAPPI Water Committee have mutual interests. Definitely, these committees should cooperate to strike a line of demarcation in order that effort is not duplicated.

The literature covering both aerobic and anaerobic areas of biological treatment is prolific. Most recently noted for the paper industry was the report of Peters (*4*) and Lucas (*3*) on their work at Downington with a bio-oxidized sludge system. Again, *Chemical Engineering* (*1*) recently referred to research at the University of Texas which stated that waste stabilization lagoons can be designed and operated to do the job of complete biological treatment plants of the trickling filter or activated sludge type.

Biological processes extend the scope of external treatment for re-use of clarified waters. In many cases the quality of effluents from biological plants efficiently removing biochemical oxygen demands has been excellent. It can be expected that these efficient processes will be improved to render clarified waters of comparable or better quality than many raw river waters now being used in processing. Again, the savings in heat can be important.

A review of the excellent text by Eckenfelder and O'Connor (*2*) is, indeed, enlightening in a comprehensive study of bio-oxidation of organic wastes. With their kind permission, their classification will be drawn upon to describe the general areas of aerobic biological treatment processes.

Stabilization Basins. "May be defined as a lagoon of significant depth in which aerobic conditions are maintained by recirculation or aeration with mechanical or diffusion equipment. The purification capacity of a stabilization basin is comparable to that in natural streams since the solids and turbulence are of the same order of magnitude—also require uniform concentration."

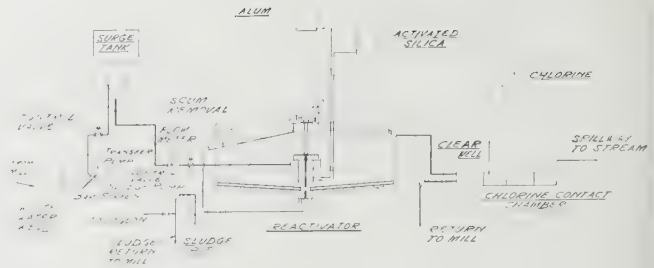


Fig. 1. Flowsheet of the primary treatment plant at Stony Brook

Activated Sludge. "May be defined as a system in which flocculated growths are continuously circulated and contacted with organic waste in the presence of oxygen. The oxygen is usually supplied from air bubbles injected into the sludge-liquid mass under turbulent conditions. The process involves an aeration step followed by a solids-liquid separation step from which the separated sludge is recycled back for the admixture with waste. . ." Various classifications exist in this biological process, viz., conventional treatment, contact-stabilization, step aeration, modified aeration, Aero-Accelator, and total oxidation.

Trickling Filters. "The trickling filtration process may be defined as a fixed bed system over which sewage or waste is intermittently or continuously discharged and contacted with biological films on filter media. Aerobic conditions are maintained by a flow of air through the filter bed induced by the difference in specific weights of the atmosphere inside and outside the bed. Periodic sloughing of filter film is discharged to secondary clarification units. Trickling filters may be broadly classified into high rate and low rate systems."

Eckenfelder and O'Connor also present an informative program of laboratory evaluation for bio-

Fig. 2. Pictorial view of the primary treatment plant at Stony Brook

oxidation design which can be used advantageously for preliminary design criteria.

SLUDGE DIGESTION AND GAS UTILIZATION

A by-product of either primary or secondary treatment is sludge digestion and gas utilization. Accumulated sludge, fairly concentrated containing unstable and putrescible solids, is stabilized by anaerobic digestion. This is accomplished in digesters in which the sludge is kept covered, collecting the supernatant liquid and gas, and controlling a favorable environment for the proper development of microorganisms. Temperature and pH control, and gentle mixing are required. Provisions must be made for relatively uniform entrance of sludge and proper drawoff of digested sludge as well as supernatant and gas. The gas produced has a low level of fuel value. It can be used to generate power or heat.

AN EXAMPLE OF PRIMARY TREATMENT

At the Stony Brook Division of the Whippany Paper Board Co., Inc., at Whippany, N. J., a primary clarification plant for the external treatment of wastes from the paperboard mill has been operating successfully over the past $3^1/_2$ years.

The small Stony Brook is a tributary of the Whippany River. The Whippany in turn flows into the Passaic under the jurisdiction of an enforcing commission. This commission controls the upper Passaic River because it is the source of supply for a large potable water treatment plant located at Little Falls, N. J.

The Stony Brook Division produces about 120 tons of chip, newsboard, and other specialty board products. It discharges approximately 1.7 M.G.D. into a Graver Reactivator 65 ft. in diameter by 17 ft. deep. This unit has a design capacity of 3 M.G.D. with surges to 4 M.G.D.

By extensive internal re-use of the process water obtained from the brook and then by return of 1.2 M.G.D. of "reactivated" water to the process, only 0.5 M.G.D. is discharged to the brook, after chlorination in a chlorine retention tank. Approximately 240 p.p.m. of alum and 10 p.p.m. of activated silica are used to clarify the water. With an exceptionally heavy dosage of 300 lb. of chlorine required for the 0.5 M.G.D. discharged, the total chemical cost is about $55 per M.G.D.

Table I. Typical Water Analysis
Process Waters—Stony Brook

	River water	*Clarifier influent*	*Clarifier effluent*
Total hardness, as $CaCO_3$	50	136	117
M. O.[a] alkalinity, as $CaCO_3$	24	20	0
P.[b] alkalinity, as $CaCO_3$	0	0	0
Free carbon dioxide, as CO_2	6	52	160
Total iron, as Fe	1.1	3.3	1.0
Silica, as SiO_2	6.4	32	37
Turbidity, as SiO_2	30	600	50
Sediment, color	Yellow	Gray	Gray
Sediment, nature	Very fine	Fine & long	Fine
Color, A.P.H.A.[c]	40	30	55
Odor description	None	Musty	Musty
Total suspended solids	15.6	425	16.6
Suspended solids, lb./1000 gal.	0.13	3.6	0.14
pH of solution	7.3	5.0	3.3[d]
Suspended solids of sludge 19,780 p.p.m. (165 lb./1000 gal.)			

[a] M. O. = methyl orange.
[b] P. = phenolphthalein.
[c] A.P.H.A. = American Public Health Association.
[d] Drop in pH because clarifier effluent sample obtained was a chlorinated sample from chlorine detention chamber.

A flowsheet of the process is shown in Fig. 1; it is self-explanatory. A pictorial view is shown in Fig. 2. A typical analysis of the raw water and whitewater before and after treatment is given in Table I.

It is interesting to note that the total hardness of the clarifier effluent returning to the mill is not undesirable. It is also interesting to note that the effluent turbidity, color, and sediment have not increased appreciably over the raw water. Actually the suspended solids of the effluent are comparable to those in the raw water. The reduction of 96% in suspended solids through the reactivator is remarkable. As expected, there is some difference in odor.

The value of heat saving is of a great deal of importance. An annual mean temperature difference between mean ambient raw water and mill process water is 70°F. Since the 1.2 M.G.D. of water returned to the mill has been heated, 700,000 B.t.u.'s are saved per day. At an average cost of $0.50 for 1000 lb. of steam, the energy saved amounts to $350 per day. This far surpasses the chemical and operating cost and depreciation.

Sludge returned amounts to approximately three tons per day. Although this material is of low grade value, the most substantial benefit is its elimination from the stream.

AN EXAMPLE OF SECONDARY TREATMENT

At the Eden Division of the Whippany Paper Board Co., Inc., at Whippany, N. J., a major expansion program was completed in the last 2 years. In the old machine room two cylinder machines produce around 285 tons of specialty board daily.

In the new mill addition, two very large machines have been installed. One of these machines is a fourdrinier producing corrugating medium. The other is a cylinder machine producing test liner. The present combined tonnage of these two machines is approximately 560 tons, but is gradually being improved.

The combined flow from these four machines has overloaded the primary treatment plant. The flow varies between 4.0 and 5.5 M.G.D. Presently primary facilities are to be enlarged. Because of stock defibration, this water is very difficult to handle for re-use. A loading of 350 p.p.m. of B.O.D. along with 300 p.p.m. of suspended solids has created an extremely difficult problem which now is soluble.

The 7.3 tons of daily B.O.D. and 6.2 tons of daily suspended solids impose a severe pollution load upon the Whippany River. As all ready indicated, the Whippany is a tributary of the Passaic River system, under rigid control by authorities. It has been necessary at Eden, to feed two tons of chlorine to the river daily to help alleviate bad stream conditions.

Even with the best operation of existing facilities, at many long intervals last summer, during dry weather conditions, adherence to minimum standards on the Whippany River made necessary the shutdown of one or more of the paper machines at Eden. The authorities imposed these restrictions only under the most unfavorable conditions and certainly were fair in their demands.

It was during this period, that the construction of a new secondary biological treatment plant of 6 M.G.D. capacity was being brought to completion. A sche-

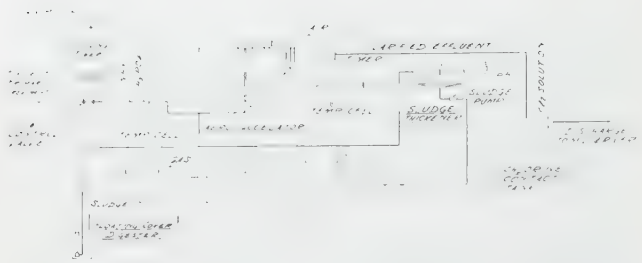


Fig. 3. Flowsheet of the secondary biological plant at Eden

matic flowsheet is shown in Fig. 3 and a pictorial view in Fig. 4.

This process incorporates a chain of units to facilitate a high degree of B.O.D. reduction and removal of suspended solids. Waste from the primary treatment plant is pumped to a cooling tower controlling incoming temperature at 85°F. From this tower the waste flows by gravity into a huge Aero-Accelator, 110 ft. in diameter, having a total volume of 1,300,000 gal. and a detention of 6.5 hr.

Air for the Accelator is provided with four turbine blowers, each having a capacity of 1760 cu. ft. per min. A minimum of 2.0 p.p.m. of dissolved oxygen is held in the Accelator by control of the number and output of these turbines. Alkali is fed to control the pH between 6.5 and 7.5. On startups the Accelator is seeded with activated sludge from a nearby sewage plant.

The Aero-Accelator, a versatile high-rate unit, combines aeration and final settling in one structure. Waste and air are introduced to an aeration and distribution zone under the hood where they are continuously and completely dispersed and distributed throughout a mass of activated sludge. Agitation and pumping is regulated with a large Vorti-Mix agitator, upon which the incoming air is imposed. The aerated mass passes upward into the center of the unit, and flows out through adjustable weir plates.

The sludge is dynamically separated from the treated liquor and recirculated to the bottom. Although oxygen transfer takes place only in the primary draft tube, bio-oxidation is considered to take place through both the inner and outer draft tube. Ammonia and phosphoric acid are fed as nutrients.

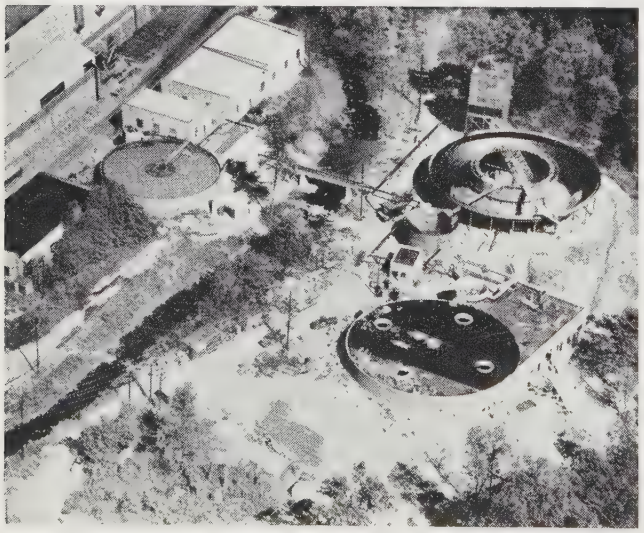


Fig. 4. Aerial view of the secondary biological plant at Eden

Sludge is discharged automatically, at timed intervals, into a thickener which is 35 ft. in diameter and 9 ft. deep. The quantity amounts to approximately 12 tons of solids per day at 2% consistency. Supernatant overflow is returned to the Accelator.

From the thickener the sludge is pumped into an anaerobic digester 100 ft. in diameter by 26 ft. deep having a capacity of 1,500,000 gal. In this unit, decomposition of the putrescible sludge is completed and accompanied by the production of low grade gas. A small second stage floating cover digester, 20 ft. in diameter by 27 ft. deep, having a capacity of 63,000 gal. completes the process. This unit operates as a variable liquid level controller and gas holder. Data on sludge, sludge handling and gas production are not available at this time.

Clarified effluent from the Aero-Accelator flows by gravity to a chlorine contact tank 35 ft. in diameter by 18 ft. deep, having a capacity of 122,000 gal. Chlorine is injected into this tank to provide for a completely sterile effluent. Pumping facilities have been incorporated to return chlorinated effluent back to the mill, with the excess being discharged to the Whippany River.

Presently it is too early to provide any extensive operating data. Test results of trial runs have indicated that B.O.D. reductions in the order of 89 to 96% can be achieved. At metastable operation, the degree of removal of suspended solids varied from 82 to 88%.

The clarified effluent from the Accelator at times has looked better than the raw river water used for process water. It is interesting to note that the depreciation on this plant over a 10-year period will be offset completely by elimination of lost time such as has occurred during the summer months in 1959. The loss during one such week equals the annual depreciation. Again, the heat savings by the re-use of this water in processing should be of a substantial magnitude.

THE OUTLOOK

The advance in the science of primary and secondary waste treatment in the paper and paperboard industry has provided much useful knowhow for those who are confronted with the problem of treating their own wastes in order to conform to stream standards or achieve other economies in their operation.

The waste problem should be approached from the viewpoint of external treatment of effluent white waters so processed that they may be re-used if necessary. Each type of paper manufacturer will have his own individual problems to solve. It looks as though expediency will accelerate these ultimate solutions.

LITERATURE CITED

1. Anon., *Chem. Eng.* 67, No. 1: 103 (Jan. 11, 1960).
2. Eckenfelder, W. W. and O'Connor, D. J., "Bio-oxidation of Organic Wastes—Theory and Design." Rev. ed., New York, N. Y. Civil Eng. Dept., Manhattan State College, 1959, pages 101–127, II-1–II-4.
3. Lucas, S. J., *Tappi* 42, No. 12: 177A–178A (Dec., 1959).
4. Peters, J. G., *Tappi* 42, No. 12: 175A–176A (Dec., 1959).
5. Rudolfs, W. (editor), "Industrial Wastes—Their Disposal and Treatment," A.C.S. Monograph No. 118, by H. Gehm, New York, N. Y., Reinhold Publ. Co., 1953, pp. 194–231.

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York N. Y., Feb. 22–25, 1960.

ASSOCIATION NEWS AND EVENTS

National Conferences

1960

Ninth Statistics Course, Aug. 8–19, 1960, N. C. State College, Raleigh, N. C.

Fourteenth Alkaline Pulping Conference, Aug. 22–24, 1960, Multnomah Hotel, Portland, Ore.

Forest Biology Conference, Aug. 24–27, 1960, New Washington Hotel, Seattle, Wash.

Eleventh Testing Conference, Sept. 27–29, 1960, Pantlind Hotel, Grand Rapids, Mich.

Fifth Deinking Conference, Oct. 5–7, 1960, Conway Hotel, Appleton, Wis.

Tenth Corrugated Containers Conference, Oct. 10–13, 1960, Royal York Hotel, Toronto, Ont.

Fifteenth Plastics Conference, Oct. 17–19, 1960, Syracuse Hotel, Syracuse, N. Y.

Fifteenth Engineering Conference, Oct. 24–28, 1960, Robert Meyer Hotel, Jacksonville, Fla.

Fundamental Research Conference, Nov. 3–5, 1960, Northampton Hotel, Northampton, Mass.

1961

46th Annual Meeting, Feb. 19–23, 1961, Commodore Hotel New York, N. Y.

Twelfth Coating Conference, May 15–17, 1961, Statler-Hilton Hotel, Buffalo, N. Y.

Twelfth Testing Conference, Aug. 15–18, 1961, Queen Elizabeth Hotel, Montreal, Que.

Eleventh Corrugated Containers Conference, Sept. 11–13, 1961, St. Francis Hotel, San Francisco, Calif.

Fourteenth Mechanical Pulping Conference, Sept. 19–21, 1961, Edgewater Beach Hotel, Chicago, Ill.

Symposium on Formation and Structure of Paper, Sept. 25–29, 1961, B.P.B.M.A., Oxford, England.

Sixteenth Plastics Conference, Oct. 9–11, 1961, French Lick Sheraton Hotel, French Lick, Ind.

Sixteenth Engineering Conference, Oct. 15–19, 1961, Shoreham Hotel, Washington, D. C.

Fifteenth Alkaline Pulping Conference, Nov. 1–3, 1961, Rice Hotel, Houston, Tex.

1962

47th Annual Meeting, Feb. 18–22, 1962, Commodore Hotel, New York, N. Y.

Thirteenth Coating Conference, May 14–16, 1962, Netherland-Hilton Hotel, Cincinnati, Ohio.

Thirteenth Testing Conference, Sept. 18–20, 1962, Benjamin Franklin Hotel, Philadelphia, Pa.

Seventeenth Engineering Conference, Oct. 14–19, 1962, Queen Elizabeth Hotel, Montreal, Que.

Twelfth Corrugated Containers Conference, Oct. 23–26, 1962, Statler-Hilton Hotel, Boston, Mass.

Sixteenth Alkaline Pulping Conference, 1962, Savannah, Ga.

1963

Fourteenth Coating Conference, May 19–22, 1963, French Lick Sheraton Hotel, French Lick, Ind.

Thirteenth Corrugated Containers Conference, Oct. 22–25, 1963, Statler-Hilton Hotel, Detroit, Mich.

Eigteenth Engineering Conference, 1963, Chicago, Ill.

Testing Instruments Exhibit

The Eleventh Testing Conference will feature an exhibit of instruments of those manufacturers or dealers who are interested in displaying their equipment. Because of the Conference's important symposium on relative humidity, manufacturers of relative humidity measuring and controlling equipment in paper test rooms are also invited to participate.

The annual testing conference sponsored by the Pulp and Paper Industry will be held at the Pantlind Hotel, Grand Rapids, Mich., Sept. 27 through 29, 1960. Those interested in participating in this exhibit should contact A. J. Winchester, Technical Secretary, TAPPI, 360 Lexington Ave., New York City.

Standards Ballot

The Standards Committee announces that revisions of the following methods were approved as Official Standards by the ballot of January, 1960:

T 2 m-58 Methoxyl Groups in Wood
T 3 m-58 Moisture in Wood Chips and Sawdust by Toluene Method
T 208 m-58 Moisture in Pulp by Toluene Method
T 425 m-59 Opacity of Paper
T 439 m-58 Titanium Pigments in Paper (with minor modifications)
T 600 m-58 Analysis of Formaldehyde
T 612 m-58 Analysis of Soda Ash

Revision of Method T 220 m-58, Testing of Pulp Hand Sheets, was not approved.

Paper Industry Career Guidance Committee

The Paper Industry Career Guidance Committee has announced the beginning of its first industry-wide Education Status Review. This review was started on May 20 with the mailing of a questionnaire to more than 1000 pulp, paper, and paperboard manufacturers and converters in the United States. The purpose of the review is to accurately determine the number of college graduates now employed in the industry and the number needed in the next 5-year period, according to the special skills in which they were trained.

"The tabulated results of the survey will indicate clearly the areas of industry need for specially trained people. This information will help the committee plan a specific program designed to lead young people toward career training which will equip them for employment in the paper and allied industry," according to Walter B. Morehouse, committee chairman.

Organized in September, 1959, the Paper Industry Career Guidance Committee is unique in the industry. For the first time in its history the pulp, paper, and paperboard industry, its suppliers and its merchants have joined together to plan and execute a program; in this instance, a career guidance program. Cooperating on the committee are: American Paper and Pulp Association, National Paperboard Association, National Paper Trade Association, Paper Industry Management Association, and the Technical Association of the Pulp and Paper Industry.

William H. Chisholm, president of Oxford Paper Co. and chairman of APPA's Public Relations Committee says:

"The formation of the Paper Industry Career Guidance Committee provides a central organization in which the whole industry can develop a unified career guidance program.

"It is hoped that all segments of our diverse industry will take advantage of this opportunity to do an important job together. A prompt reply to the Education Status Review would be the first step in that direction."

The purpose of the committee is to attract and guide young people toward careers in the pulp and paper industry. The Paper Industry Career Guidance Committee will operate programs and produce materials which will inform young people of the employment and career opportunities in the pulp and paper industry. It will do what it can to encourage all the people in the industry to use its services, to actively participate in its programs and to assist in securing the widest distribution possible of the materials the committee produces. The members of the committee are Walter B. Morehouse, vice-president, Nopco Chemical Co., and chairman of the committee; Theodore H. Davis, public relations director, American Paper and Pulp Association, and committee secretary-treasurer; Arnold Posner, secretary, S. Posner Sons, Inc., and assistant treasurer of the committee; J. A. Bradnick, public relations manager, West Virginia Pulp and Paper Co.; C. Ives Gehring, pulp and paper mill manager, Sealright-Oswego Falls Corp.; William Gittens, National Paperboard Association; John R. Kennedy, vice-president, Federal Paper Board Co., Inc.; Richard T. Trelfa, vice-president, Perkins-Goodwin Co.; A. J. Winchester, technical secretary, Technical Association of the Pulp and Paper Industry; and Lawrence E. Witte, public relations director, National Paper Trade Association.

Headquarters of the Paper Industry Career Guidance Committee are on the 38th floor, 122 E. 42nd St., New York 17, N. Y.

Printing Research Proceedings

The proceedings of the Fifth International Conference of Printing Research Institutes held at Lehigh University, Bethlehem, Pa., in 1959, will be made available in book form at a nominal price to anyone placing his order in advance of publication.

The title of the book will be "Advances in Printing Science and Technology, Volume I—Printing Inks and Color." The volume will include the papers presented and discussions held during the fifth conference, and will be edited by W. H. Banks of London, England.

In order to give TAPPI members the benefit of the low bulk price of $4.00 per copy for the book, headquarters will process orders received before August 15. The order form below or a letter may be used, but it must reach TAPPI headquarters before August 15 in order to be processed.

A check or money order should accompany your order. The book will be shipped to you from TAPPI headquarters as soon as received.

Fourteenth Alkaline Pulping Conference

P. J. Frost, Crown Zellerbach Corp., Camas, Wash., technical program chairman for the Sulfite Pulping Committee's portion of the Fourteenth Alkaline Pulping Conference has announced the following three papers will be presented Tuesday afternoon Aug. 23, 1960.

1. "Multistage Sulfite Pulping of Jack Pine and Mixed Oaks," by E. L. Keller, N. Sanyer, and G. H. Chidester, U. S. Forest Products Laboratory, Madison, Wis.
2. "Continuous Sodium Sulfite Cooking of Softwoods," by C. A. Richardson, Technical Director of Blandin Paper Co., Grand Rapids, Minn.
3. "High Yield Sulfite Pulping (exact title unknown)," R. Strapp, Pt. Claire, Que.

Details of the Alkaline Pulping portion of the conference were announced in the June issue of *Tappi*.

This conference, which will be held Aug. 22–24, 1960, at the Multnomah Hotel in Portland, Ore., promises to present a most interesting program. Attention is called to the fact that those planning to attend should preregister, using the form which appeared in the June issue of *Tappi*. Additional forms are available from TAPPI Headquarters.

Forest Biology Conference

R. F. Seidl, Simpson Timber Co., Seattle, Wash., general chairman of the Forest Biology Conference, has announced additional arrangements for the conference which is to be held Aug. 24–27, 1960, at the New Washington Hotel in Seattle, Wash.

In addition to some changes in the technical program which is shown below in its revised entirety, Mr. Seidl stated the field trip on Saturday, Aug. 27, 1960, would include visits to the following:

1. Col. W. B. Greeley Forest Nursery, Nisqually, Wash.
2. Perpetual Forests, Inc., Seed Orchard, Grand Mound, Wash.
3. Manning Seed Co., Roy, Wash.

Lunch will be served at the Tumwater Inn, Tumwater, Wash.

Those planning to attend the TAPPI Forest Biology Conference are urged to preregister, using the form which was printed in the June issue of *Tappi*. Additional preregistration forms are available from TAPPI Headquarters. Hotel reservations may be obtained by writing to "TAPPI Forest Biology Conference," New Washington Hotel, Seattle, Wash.

WEDNESDAY, AUG. 24, 1960

2:00 p.m. ***General Session (Windsor Ballroom)***

D. D. Stevenson, Buckeye Cellulose Corp., Foley, Fla., *moderator*

Introductory remarks.

Principal addresses by J. L. McCarthy, University of Washington, Seattle, Wash.; and L. R. Thiesmeyer, Pulp and Paper Research Institute of Canada, Montreal, Que.

TAPPI, 360 Lexington Ave., New York 17, N. Y.

Please send _____ copies of "Advances in Printing Science and Technology, Vol. I" to_____

_____

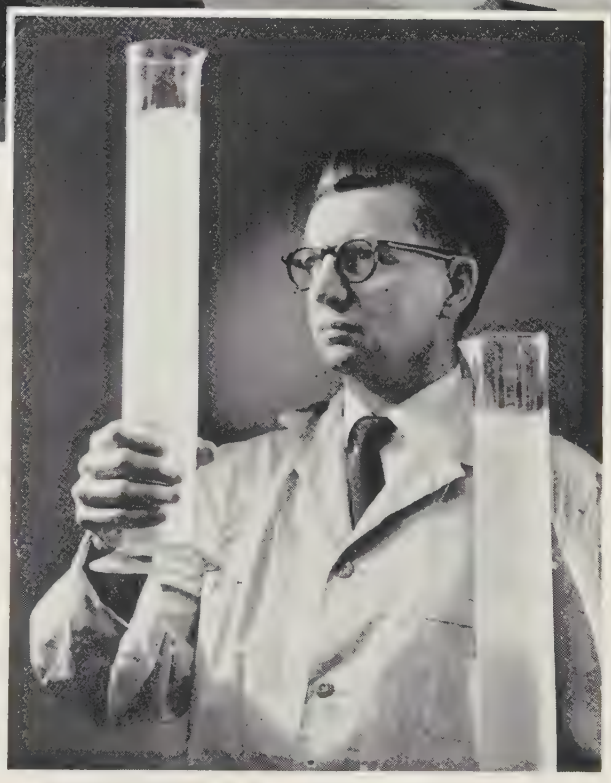
_____

Enclosed $_____ (Price $4.00 per copy postpaid)

From the Paper Research Laboratory of The New Jersey Zinc Company
ONE of a Series of Test Procedures on Horse Head Titanium Dioxide

Means of reducing loss of pigment in white water is one of the subjects receiving special attention in tests conducted on this Noble and Wood machine.

RETENTION



Pigment retention studies at the New Jersey Zinc paper laboratory embrace all aspects of the problem, both fundamental and practical. Investigations are under way to develop a better insight into the various mechanisms of retention, and the degree to which each is influenced by such factors as type of pigment, dispersion of pigment, surface characteristics of pigment, type of pulp, degree of beating, pH and freeness of stock, rate of drainage, and effect of retention additives.

This important phase of New Jersey Zinc research, directed toward more efficient utilization of titanium dioxide in paper products, is your assurance of even higher standards of HORSE HEAD titanium dioxide quality.

HORSE HEAD® TITANIUM DIOXIDE

THE NEW JERSEY ZINC COMPANY, 160 Front St., New York 38, N. Y.

Founded 1848

Also Distributed by BULKLEY DUNTON PULP CO. INC. • New York, N. Y. • Kalamazoo, Mich.

Pigments Monograph Errata

During the printing of Monograph No. 20, Paper Coating Pigments, corrections for proofs of chapter III were inadvertently omitted without the knowledge of the subcommittee or the authors. Please insert this errata sheet in your copy of the monograph.

P. 29—Last line add (10) to references.

P. 30—1st par. line 4—Change (8) to (28).
1st par. line 4–6—Insert after "In this process" "if"; after "caustic soda" strike out "so"; after "calcium carbonate properties" strike out "are" and insert "may be."
2nd par. line 4—Strike out entire line.
2nd par. line 7—Strike out (10).
3rd par. line 2—Change "sulfate" to "soda."
3rd par. line 5—Add (8) after (14).
Last par.—Add (29) after "dolomitic limestone."

P. 51—last line—After (0.5 micron or less) strike out rest of line as well as rest of sentence on page 52, add "which can be used as a coating pigment are usually exaggerated if the production yield of its co-product is the major consideration (i.e., Lime-Soda Process)."

P. 53—To literature cited add (28) Brooks & Rafton, U. S. patent 2,062,255 (Nov. 24, 1936), (29) Rafton, U. S. patent 1,415,391 (May 9, 1922).

THURSDAY, AUG. 25, 1960

9:00 a.m. ***First Session (Windsor Ballroom)***

Theme: "Evaluation of Wood Properties"

R. W. Wellwood, University of British Columbia, Vancouver, B. C., *moderator*

1. "Some Mechanical Properties of Wood Fibers in Tension," by B. A. Jayne, Institute of Technology, Washington State University, Pullman, Wash.
2. "Pulping Southern Pine Increment Cores by Means of a Microkraft Procedure" (author to be announced).
3. "Variations and Periodicity of Summer Wood Formation in Douglas-Fir," by R. W. Kennedy, University of British Columbia, Vancouver, B. C.

1:00 p.m. ***Second Session (Windsor Ballroom)***

Panel Discussion: "Can Biological Improvement of Fiber Properties Keep Pace with Technological Advances"

H. E. Dadswell, Div. of Forest Prod., C.S.I.R.O., Melbourne, Australia, *moderator*

Paper Technologists: W. A. Chilson, Forest Prod. Lab., U. S. Forest Service, Madison, Wis.; P. J. Frost, Crown Zellerbach Corp., Camas, Wash. *Forest Biologists:* S. S. Pauley, School of Forestry, University of Minnesota, St. Paul, Minn.; One other to be announced.

6:00 p.m. ***Hospitality Hour (Flamingo Room)***

7:00 p.m. ***Banquet (Windsor Ballroom)***

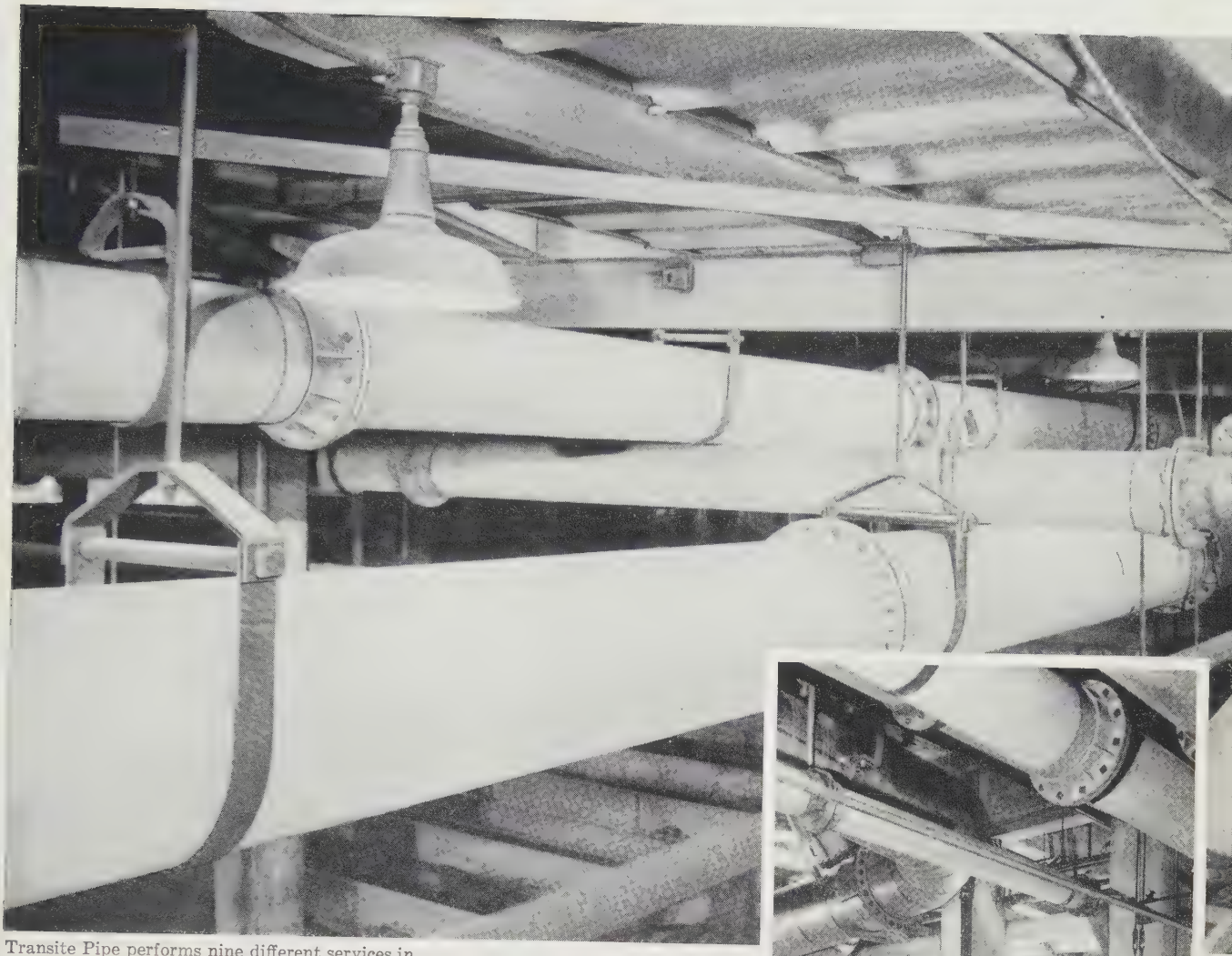
FRIDAY, AUG. 26, 1960

9:00 a.m. ***Third Session (Windsor Ballroom)***

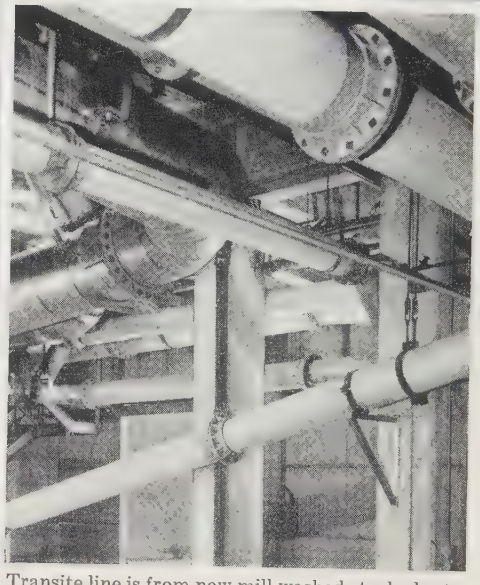
Theme: "Variations in Wood Properties"

M. D. McKimmy, School of Forestry, Oregon State College, Corvallis, Ore., *moderator*

1. "Tree to Tree Variations and Gross Heritability of Wood Characteristics of *Pinus Radiata*," by H. E. Dadswell and J. W. P. Nicholls, Div. of Forest Products, C.S.I.R.O., Melbourne, Australia; and J. M. Fielding and A. G. Brown, Forestry and Timber Bureau, Canberra, Australia.
2. "Anatomical Responses of Loblolly Pine to Soil Water Deficiencies," by D. M. Smith, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.
3. "Effect of Fertilizer in Wood Properties of Loblolly Pine," by B. J. Zebel, F. Goggans, T. E. Maki, and F. Henson, School of Forestry, North Carolina State College, Raleigh, N. C.
4. "Variation in Specific Gravity and Fiber Length in Wood of Yellow Poplar," by E. Thorbjornsen, Dept. of Forestry, University of Tennessee, Knoxville, Tenn.



Transite Pipe performs nine different services in the St. Regis Company's Jacksonville Plant.



Transite line is from new mill washed stock chest to old mill washed stock chest.

Transite Pipe helps St. Regis work giant new "Seminole Chief" at full capacity!

Chief Engineer, L. C. Crowder, tells of experience with Transite . . . how its flow capacity and "cleanliness" determined its selection

Almost by the day, we see new reports on the added economy and performance that Transite® Pipe brings to water and stock lines. One such report comes to us from the St. Regis Company's Jacksonville Plant:

"When we recently installed the Seminole Chief, one of the largest capacity machines in the industry," says Mr. Crowder, Chief Engineer, Pulp & Paper Division, "production jumped from 300 to 1300 tons per day. And water capacity and stock cleanliness became more important than ever.

"Six years' experience with Transite Pipe told us it would do the job. It has an exceptionally smooth interior surface that offers minimum frictional resistance to the flow of liquids. Of equal importance, it is immune to tuberculation and is resistant to sliming and bacterial growths.

"For all those reasons we chose Transite Pipe for our entire system. Carrying water and stock in nine different types of lines, Transite helps us maintain an even and continual flow rate . . . with required stock cleanliness."

Proven installation economy, maintenance savings and resistance to stock build-up—make Transite Pipe well worth your investigation. Meanwhile, let us send you copies of TR-113A, a 24-page illustrated brochure and TR-180A, the Transite installation guide for process systems. Send for them today. Address Johns-Manville, Box 147A, New York 16, N.Y.

JOHNS-MANVILLE JOHNS MANVILLE JM PRODUCTS

1:00 p.m. ***Fourth Session (Windsor Ballroom)***

Theme: "Influence of Wood and Fiber Properties on Pulp and Paper Characteristics"

J. M. McEwen, Weyerhaeuser Timber Co., Everett, Wash., *moderator*

1. "Pulp and Paper Processes and Their Characteristic Differences," by H. W. Bialkowsky, Weyerhaeuser Co., Longview, Wash.
2. "Pulpwood Properties—Response of Processing and of Paper Quality to Their Variation," by E. F. Thode, The Institute of Paper Chemistry, Appleton, Wis.
3. "Relationships between Hardwood Fiber Characteristics and Pulp Sheet Properties," by F. M. Tamolang, Bureau of Forestry, Manila, Philippines.

The TAPPI Forest Biology Conference was scheduled in conjunction with the announced dates of the Fifth World Forestry Congress, Aug. 29–Sept. 10, 1960, at the University of Washington, Seattle, Wash. It was felt many people would be interested in attending both meetings. A condensed program of the World Forestry Congress is as follows:

Fifth World Forestry Congress

CONDENSED PROGRAM

Seattle, Wash.

Aug. 29 to Sept. 10, 1960

Section I: Silviculture and Management

A major subject-matter field, including forest surveys (objectives, standards, design, aerial photogrammetry, etc.); silviculture and management, with particular reference to semiarid and temperate zones (problems unique to the tropics will be dealt with in a separate section) and soils and ecology.

Section II: Forest Genetics

The improvement of forest trees and seeds by breeding and selection, including discussion of progress to date in genetics and tree improvement by major regions and the role of international cooperation in the exchange of breeding material and in forest tree seed certification.

Section III: Forest Protection

The entire field of forest protection from fire, insects, and disease. Suggested discussion topics include the intercontinental spread of forest pathogens; new approaches to forest insect and disease control including chemical, biological, and cultural methods; progress in forest fire-fighting methods and organization; and the role of weather and climate in forest protection.

Section IV: Forest Economics and Policy

Broad questions of economics and policy including problems in the formulation of forest policy suitable to the early stages of forestry development; the role of requirements analysis in formulating forest policy; the effect of population pressures on timber needs; and institutional arrangements for forestry.

Section V: Forest Education

Various phases of public, subprofessional, and professional education with particular attention to the problems of technically underdeveloped areas.

Section VI: Forest Products

The broad field of forest products, their utilization, and the forest industries. Discussion topics will include recent research on the structure and physical and mechanical properties of wood; factors affecting wood quality and its determination; the chemistry and biochemistry of wood; lumber manufacturing and wood processing; integrated utilization; wood preservation; and pulp and paper technology.

Section VII: Forest and Range Watersheds

Problems of forest and range watersheds including a symposium on forest practices in controlling avalanches, floods, and soil erosion; methods of protecting soil and water supplies in managed forest and grazing areas; and a symposium on shelterbelts.

Section VIII: Forest Recreation and Wildlife

The recreational uses of forest lands; problems of preserving the pleasing landscape; wildlife management, including game production, protection, and harvesting; and problems of forest parks, wilderness, and natural reserves.

Section IX: Forest Operations

A discussion of logging and other forest operations including the preparation and use of logging plans; the training and safety of forest workers; the effect of mechanization on forest labor efficiency; efficient cable tractor and animal skidding; and the primary transport of logs and forest products by water and land.

Section X: Tropical Forestry

The special problems of tropical areas and tropical forestry, such as shifting agriculture; present-day obstacles in utilization and land tenure; and special problems of silviculture and management.

Eleventh Testing Conference

W. H. Aiken, Personal Products Corp., Milltown, N. J., general chairman of the Eleventh Testing Conference, has announced the technical program for the conference, which is to be held Sept. 27–30, 1960, at the Pantlind Hotel, Grand Rapids, Mich.

T. W. Lashof, National Bureau of Standards, Washington, D. C., is chairman of the relative humidity symposium and W. R. Willets, Titanium Pigment Corp., New York, N. Y., is general program chairman of the conference. C. E. Jakeway, Packaging Corp. of America, Grand Rapids, Mich., is in charge of local arrangements. Working with the conference committee are W. L. Kite, Lee Paper Co., Vicksburg, Mich., Chairman and J. D. Chadderdon, The KVP Co., Kalamazoo, Mich., chairman and vice-chairman respectively, of the Kalamazoo Valley Section TAPPI.

MONDAY, SEPT. 26, 1960

9:00 a.m.–5:00 p.m. Steering Committee Meetings
5:00 p.m. Local Arrangements Committee
6:00 p.m. Division Officers Dinner (Sadler Room)
6:00–9:00 p.m. Registration (Lobby)

TUESDAY, SEPT. 27, 1960

8:00 a.m.–6:00 p.m. Registration (Lobby)
9:00 a.m. Opening Session (Ball Room)
10:00 a.m. Committee Meetings

WEDNESDAY, SEPT. 28, 1960

8:30 a.m.–7:00 p.m. Registration (Lobby)
9:00 a.m.–5:00 p.m. Symposium: "Relative Humidity and Paper Test Methods" (Ballroom)

T. W. Lashof, National Bureau of Standards, Washington, D. C., *moderator*

"Effect of Relative Humidity on Some Physical Properties of Paper," by W. E. Bennett, research physicist, and Miss D.

This ion exchange unit deionizes boiler make-up water at Crown Zellerbach paper mill, Bogalusa, Louisiana.

AMBERLITE ion exchange resins condition water for Crown Zellerbach boilers

AMBERLITE ion exchange resins are used to remove silica and other ionized impurities from make-up water for high pressure boilers at the Bogalusa Mill of the Crown Zellerbach Corporation. The deionized water is needed for 900 psi boilers that supply steam for turbine-driven power generators. Effluent steam from the turbines is piped to paper-machine dryers.

To furnish the make-up, well water containing the high silica level of 30 ppm is fed to a two-bed deionizing system having 127 cubic feet of AMBERLITE IR-120 in the cation exchanger and 207 cubic feet of AMBERLITE IRA-400 in the anion exchange unit. Ion exchange treatment reduces silica content to 0.20 ppm and conductivity to 4 micromhos.

Flow rate of the water-conditioning system is 350 gallons per minute. Design specifications call for regeneration of the ion exchange beds after treatment of 505,000 gallons of water. However, the high capacity of the ion exchange resins has permitted the units to run consistently far beyond this limit, without exceeding the guaranteed silica content in the treated water.

Water conditioning is only one of the many fields in which AMBERLITE ion exchange resins have solved commercial problems. Others include recovery of costly metals from industrial wastes, removal of contaminants from numerous chemicals, and extraction of pharmaceuticals from reaction mixtures. Write for our booklets *Ion Exchange with the* AMBERLITE *Resins* and *If You Use Water* for more information on ion exchange applications.

AMBERLITE *is a trademark, Reg. U. S. Pat. Off. and in principal foreign countries.*

Chemicals for Industry

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square, Philadelphia 5, Pa.

M. Crook, British Paper and Board Industry Research Association, Kenley, England.

"The Effect of Relative Humidity on the Stress-Strain Properties of Kraft Multiwall Paper," by G. A. Bernier, and W. E. Carlson, St. Regis Paper Co., Deferiet, N. Y..

"Reasons for 65% R. H. and 20°C., and Other Topics," by W. Brecht, Institute fur Papierfabrikation, Technische Hochschule Darmstadt, Germany.

"Effect of Relative Humidity on the Evaluation of Paper Properties," by W. A. Wink, Chief, The Institute of Paper Chemistry, Appleton, Wis.

"Some Developments in the Measurement of Relative Humidity," by A. C. Poulter, Albert E. Reed & Co., Ltd., Larkfield, England.

"Standards in the Measurement of Relative Humidity," by A. Wexler, National Bureau of Standards, Washington, D. C.

"The Design and Control of Test Rooms and Small Ovens," by J. A. Cairns, The Printing, Packaging & Allied Trades Research Association, Leatherhead, England.

"A Conditioning Room in Which a Great Deal of In-and-Out Traffic Does Not Upset Conditions; a Rapid Conditioner," by L. L. Clapp, Process and Production Development, St. Regis Paper Co., Pensacola, Fla.

"The Constant Temperature Room as a Testing Facility: Its Design and Construction from a User's Viewpoint," by F. M. Gavan, Armstrong Cork Co., Lancaster, Pa.

6:00 p.m. Hospitality Hour (Kent State Room)
7:00 p.m. Banquet (Ballroom)

(Speaker to be announced.)

Jointly sponsored by Kalamazoo Valley Section TAPPI and the Eleventh Testing Conference.

THURSDAY, SEPT. 29, 1960

8:30 a.m.–1:00 p.m. Registration (Lobby)

9:00 a.m. Symposium—"Water, the Most Important Non-Fibrous Raw Material" (Ballroom)

E. W. Petrich, Howard Paper Mills, Inc., Urbana, Ohio, *moderator*

"Process Water," by R. K. Bamman, Champion Paper and Fibre Co., Hamilton, Ohio.

"Waste Water," by W. A. Flower, Howard Paper Mills, Inc., Urbana, Ohio.

"Boiler Water," by M. H. Borland, Mead Corp., Chillicothe, Ohio.

2:00 p.m. General Session Ballroom

J. R. Gunning, Provincial Paper, Ltd., Georgetown, Ont., *moderator*

1. "Factors Influencing Testing of Gummed Tape," by E. Werle, Darling and Co., Chicago, Ill.
2. "Comparison of Proposed Test Methods for Measuring Adhesive Strength of Casein and Isolated Soy Protein in a Pigmented Coating," by L. E. Georgevits and W. L. Marino, The Borden Co., Bainbridge, N. Y.
3. "Survey of Sampling and Precision Requirements in Present TAPPI Test Methods," by C. A. Bicking, The Carborundum Co., Niagara Falls, N. Y.
4. "Measurement of Fiber Flexibility," by A. A. Robertson, E. Meindersma, and S. G. Mason, Pulp and Paper Research Institute of Canada, Montreal, Que.
5. "Development of Dirt Contribution Factors for Dirt in Pulpwood Chips," by E. Birkhimer, T. C. Rowland, H. B. Stanos, and B. E. Lauer, University of Colorado, Boulder, Colo. (Paper to be presented by title.)
6. "Identification of Coniferous Woods," by B. F. Kukachka, Forest Products Laboratory, Madison, Wis. (Paper to be presented by title.)

FRIDAY, SEPT. 30, 1960

8:30 a.m. Mill Visits to KVP Co., and Sutherland Paper Co., Kalamazoo, Mich. Return to Pantlind Hotel by 3:00 p.m.

Fifteenth Plastics-Paper Conference

Hotel Syracuse
Syracuse, N. Y.
Oct. 16–19, 1960

SUNDAY, OCT. 16, 1960

4:00–10:00 p.m. Registration (Assembly Foyer—10th Floor)

MONDAY, OCT. 17, 1960

8:00 a.m. Registration (Assembly Foyer—10th Floor)
9:00 a.m. Opening Remarks. E. C. Jahn, Associate Dean of College of Forestry
9:15 a.m. Wet Strength & Interfiber Bonding Session

K. W. Britt, Scott Paper Co., Chester, Pa., *chairman*

1. "The Mechanism of Retention of Wet-Strength Resins—The Rate Controlling Step," by J. W. Swanson, Institute of Paper Chemistry.
2. "Cure of Wet Strength Resins," by V. T. Stannett, College of Forestry, Syracuse, N. Y.
3. "Disposable Paper and Plastic Supplies for Military Use," Thomas George, Q. M. Research & Development Command, Natick, Mass.
4. "High Efficiency Melamine Wet Strength Resin," by C. S. Maxwell and R. R. House, American Cyanamid Co., Stamford, Conn.

2:00 p.m. Plastics Committee Session

W. N. Stickel, Texon, Inc., S. Hadley Falls, Mass., *moderator*

6. "The Delamination Strength of Latex Treated Papers," by K. Sarkanen, V. T. Stannett, and T. C. Lee.
7. "Grafting Monomers on to Cellulose and Cellulosic Fibers," by J. J. Hermans and V. T. Stannett.
8. "Fibrous Resins," by F. H. Foxlee, Union Carbide Corp., New York, N. Y.
9. "Plastics, Paper and Packaging Education," by H. Raphael, Michigan State University.
10. "The Packaging Foundation Story," by H. G. Walter.

6:00 p.m. Reception (Dutch Treat) East Room
7:00 p.m. Banquet—Ballroom

Speaker, D. Davenport, Deputy Commissioner of Commerce —N. Y. State

Subject: The State and Industries Role in Research

TUESDAY, OCT. 18, 1960

8:00 a.m. Registration—Place. Plastics in the Paper Board Industry
9:00 a.m. Session (Plastic Coating).

G. L. Booth, Dilts Machine Works, Fulton, N. Y.

11. Surface Treatment
12. "A Challenge to the Paper Industry," by C. G. Morse.
13. "Reclamation of Plastic Coated Paper Board," by J. Dow, Black Clawson Co., Shartle Div., and Author to to announced, Sealright Oswego Falls Corp.
14. "A New Approach to Cast Coating of Board," by T. Luey, Boxboard Research Institute.

1:00 p.m. Transportation to Fulton
2:00–4:00 p.m. Committee Meetings

Plastics Committee, Wet Strength & Interfiber Bonding
Plastics Laminates

6:00 p.m. Conference Committee Reception
7:00 p.m. Division Officer's Dinner

Complete One-Contract Service
Design, Installation and Maintenance of
LININGS and TILE TANKS
Stebbins installations can be made under a single contract which covers everything from the original design, which is based on a full knowledge of chemical, physical and mechanical requirements, to the finished job ready for use. Maintenance can also be included. As proved by the experience of leading mills throughout the country, you can rely completely on Stebbins service.
SINCE 1884
Specialists in
Design
Installation
and Servicing
of Linings and
Tile Tanks
STEBBINS Engineering and Manufacturing Company
SEMCO
WATERTOWN, N. Y. • PENSACOLA, FLORIDA
STEBBINS ENGINEERING CORP. — 2611 MARKET ST., SEATTLE 7, WASH.
CANADIAN STEBBINS ENGINEERING & MANUFACTURING CO., LTD.
TOWN OF MOUNT ROYAL, MONTREAL 9 • MERCHANT EXCHANGE BLDG., VANCOUVER

WEDNESDAY, OCT. 19, 1960

8:00 a.m. Registration

9:00 a.m. Plastics Laminates Session

H. A. SPENCER, Knowlton Bros., Inc., Watertown, N. Y., *chairman*

16. "Decorative Laminates—Have They Really Changed," by P. E. Fuerst, General Electric Co., Coshocton, Ohio.
17. Project 763—Test for Rate of Resin Penetration—Progress Report.
18. Project 764—Resin Solids Test—Final Report.
19. Project 765—Resin Distribution Test—Progress Report.
20. "Organo Phosphorous Epoxide Polymers," by L. M. Kindley.

2:00 p.m. Synthetic Fibers Session

T. A. HOWELLS, The Institute of Paper Chemistry, Appleton, Wis., *chairman*

Synthetic Fiber Clinic. Prepared questions and answers and/or spontaneous unorganized discussion to foster a free technical exchange. Panel members to consist of B. Henshaw, du Pont; Scherer, American Viscose; H. Ardleter, Mead; F. H. Foxlee, Union Carbide, and John Waugh, Owens Corning Fibreglas.

MILL VISITS

Tuesday Afternoon, Oct. 18, 1960

Tour I—(Plan 50 people, one bus)

1:00 p.m. Leave Hotel Syracuse via Syracuse Oswego Bus
2:00 p.m. Arrive Hammermill Paper Co.—Oswego
3:30 p.m. Leave Oswego enroute Fulton
4:00 p.m. Arrive Dilts
4:30 p.m. Leave Fulton enroute Syracuse
5:30 p.m. Arrive Hotel Syracuse

Tour II—(Plan 100 people, 3 buses)

1:00 p.m. Leave Hotel Syracuse via Syracuse Transit Co. Buses
1:30 p.m. Arrive College of Forestry, Split into two groups. Group A—Start at Paper Mill, group B—Start at Baker Labs.
3:30 p.m. Leave College en route hotel
4:00 p.m. Arrive hotel

Notes:

1. A nominal charge will be made (probably $1.00) for transportation and arrangements.
2. V. T. Stannett is host at College. R. W. Phelps is host at Dilts.

Jacksonville, Florida's fastest growing metropolis, site of TAPPI's 15th Engineering Conference, Oct. 24–28, 1960

Fifteenth Engineering Conference

The Fifteenth Engineering Conference, to be held Oct. 24–28, 1960, at the Robert Meyer Hotel in Jacksonville, Fla., will consist of 18 technical sessions with 52 papers and panel discussions to be presented according to Technical Program Chairman V. P. Owens, Combustion Engineering, Inc., New York, N. Y. Mr. Owens pointed out the program is widely diversified and should prove to be of substantial interest to those whose interest lies in the engineering aspects of the pulp and paper industry.

It is to be noted, preregistration for the conference will be employed and a form will be printed in August *Tappi* for use by those planning to attend. Additional forms will be available from TAPPI Headquarters.

Those desiring hotel reservations should write to: TAPPI 15th Engineering Conference, Robert Meyer Hotel, Jacksonville, Fla., and state date and time of both arrival and departure.

SUNDAY, OCT. 23, 1960

10:00 a.m. Local Arrangements Committee (English Room)
2:00–6:00 p.m. Committee Consultations (Essex Room)
4:00 p.m. Process Instrument Steering (French Room)
4:00 p.m. Electrical Steering (Spanish Room)
4:00 p.m. Maintenance Steering (Oxford Room)
1:00–8:00 p.m. Registration (Mezzanine)
6:00 p.m. Division Staff (Dover Room)

MONDAY, OCT. 24, 1960

7:30 a.m. Author's Breakfast, as announced
8:00 a.m.–5:00 p.m. Registration (Mezzanine)
9:00 a.m. Session I—General (Windsor North)

M. J. OSBORNE, Bowaters Southern Corp., Calhoun, Tenn., *chairman*

9:15 a.m. Session II—Electrical Engineering (Windsor North)

S. ANDERSON, West Virginia Pulp & Paper Co., New York, N. Y., *chairman*

1. "Electrical Problems in the Use of Purchased Power in Paper Mills," (Project No. 790), by J. Davey, Louisiana Power & Light Co.
2. "Overload Protection of A-C Motors," by title only, by H. A. Wright, Allis-Chalmers Mfg. Co., West Allis, Wis.
3. "Power Requirements of Feltless Pulp Machines," (Project No. 620), Final report by title only, C. C. Collins, General Electric Co., Schenectady, N. Y.
4. "Structural Board Machine Power Data," (Project no. 621), final report by title only, by M. H. Fisher, Westinghouse Electric Co., Pittsburgh, Pa.
5. "Selection of Refiner Motors," (Project No. 852), Introduction to project by title only, by C. G. Herrington, The Buckeye Cellulose Corp., Foley, Fla.
6. "End Thrust Problems and Considerations of Flexible Coupled Motors," (Project No. 789).

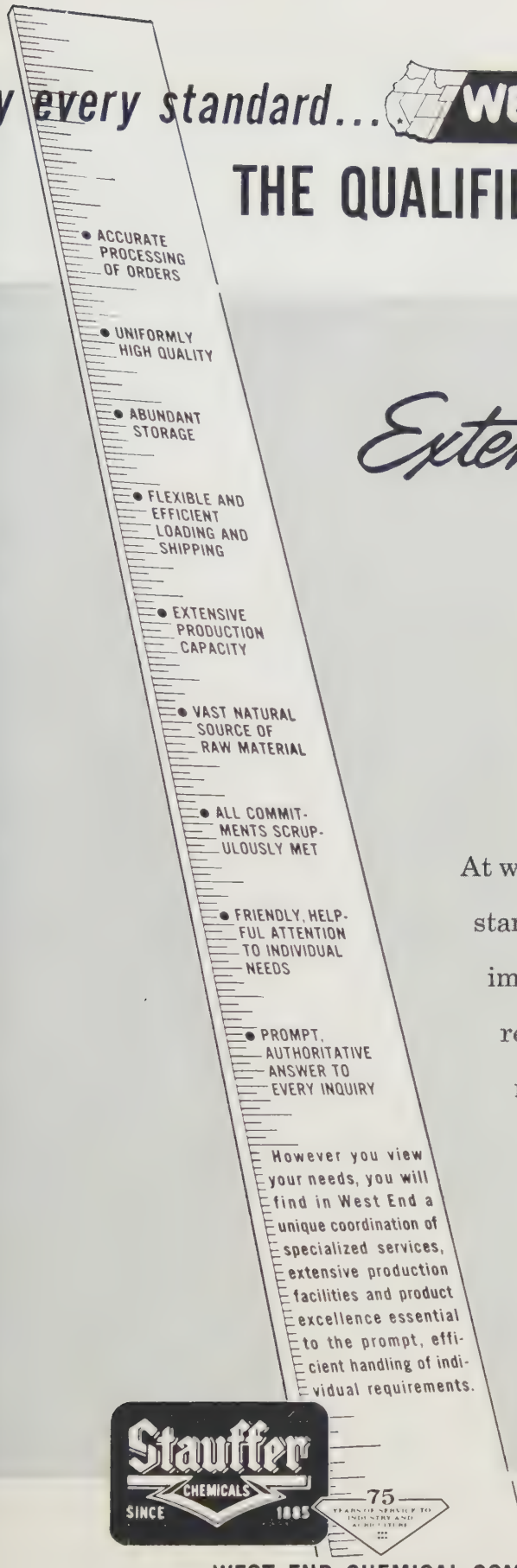
Panel Discussion. J. R. FIELDING, Union Bag-Camp Paper Co., Savannah, Ga., *moderator*

Panel Members. J. F. Fenske, Allis-Chalmers Mfg. Co., Norwood, Ohio; R. W. Foster, Champion Paper & Fiber Co., Canton, N. C.; J. V. Cundelan, Rayonier, Inc., New York, N. Y.; P. Hollingsworth, Koppers Co., Baltimore, Md.; B. J. Oberemlet, The Falk Corp., Milwaukee, Wis.; G. C. Werner, Thomas Flexible Coupling Co., Warren, Pa.

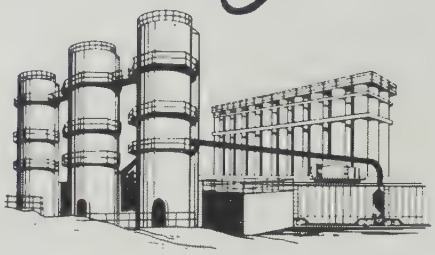
9:15 a.m. Session III—Chemical Engineering I (Process) (Windsor South)

ARTHUR W. PLUMMER, Hudson Pulp & Paper Corp., South Windham, Me., *chairman*

By every standard... WEST END MEASURES UP AS THE QUALIFIED SUPPLIER OF SALT CAKE


• ACCURATE PROCESSING OF ORDERS
• UNIFORMLY HIGH QUALITY
• ABUNDANT STORAGE
• FLEXIBLE AND EFFICIENT LOADING AND SHIPPING
• EXTENSIVE PRODUCTION CAPACITY
• VAST NATURAL SOURCE OF RAW MATERIAL
• ALL COMMITMENTS SCRUPULOUSLY MET
• FRIENDLY, HELPFUL ATTENTION TO INDIVIDUAL NEEDS
• PROMPT, AUTHORITATIVE ANSWER TO EVERY INQUIRY
However you view your needs, you will find in West End a unique coordination of specialized services, extensive production facilities and product excellence essential to the prompt, efficient handling of individual requirements.

Extensive production capacity



At work around the clock for 35 years, the constantly enlarging facilities at West End supply immediate requirements and maintain vast reserves. Production is geared to meet all normal and emergency requirements of our customers promptly, regardless of market conditions.

Stauffer CHEMICALS SINCE 1885 — 75 YEARS OF SERVICE TO INDUSTRY AND AGRICULTURE

WEST END CHEMICAL COMPANY • DIVISION OF STAUFFER CHEMICAL COMPANY

636 CALIFORNIA, SAN FRANCISCO 8, CALIF. • PLANT: WESTEND, CALIF.

1. "Final Report, Project. 121 Measure of Humidity in Presence of SO_2" by W. R. Marshall, Jr. University of Wisconsin, Madison, Wis.
2. "Continuous Freeness Recording Controller," by G. A. Chedomir, Kimberly-Clark Corp., Neenah, Wis.
3. "The Effect of Some Organic Substances on Oxygen Absorption in Bubble Aeration," by S. A. Zieminski, C. C. Goodwin and R. L. Hill, University of Maine, Orono, Me.

12:30 p.m. Luncheons

Drying (Essex Room)
Engineering Economics (Oxford Room)
Maintenance Engineering (Dover Room)
Mechanical Engineering (French Room)

2:00 p.m. Session IV—Fluid Mechanics I (Windsor North)

C. A. Lee, Formex Co. Div. of F. C. Huyck & Sons, Knoxville, Tenn., *chairman*

1. "The Physics of Flow Through Porous Media," by A. E. Scheidegger, Imperial Oil Research Lab., Calgary, Alberta.
2. "Resistance of Wire Screens to Flow of Water," by W. L. Ingmanson, S. T. Han and W. T. Myers, The Institute of Paper Chemistry, Appleton, Wis.
3. "Drainage in a Rotary Vacuum Former," by S. T. Han, The Institute of Paper Chemistry, Appleton, Wis.
4. "The Creep Properties of Wet Pulp Mats Under Compression," by H. D. Wilder, The Institute of Paper Chemistry, Appleton, Wis.

2:00 p.m. Session V—Chemical Engineering II (Windsor South) (Operations Research)

E. F. Thode, The Institute of Paper Chemistry, Appleton, Wis., *chairman*

1. "Introductory Remarks—Techniques Must Not Obscure Problems," by E. F. Thode, The Institute of Paper Chemistry, Appleton, Wis.
2. "Linear Programming," by R. W. Van Duyne, West Virginia Pulp & Paper Co., New York, N. Y.
3. "Response Surface Techniques," by C. W. Carroll, Scott Paper Co., Chester, Pa.
4. "Simulation," by W. E. Winans, International Business Machine, Green Bay, Wis.

6:00 p.m. Process Instrumentation Committee Meeting (French Room)

TUESDAY, OCT. 25, 1960

7:30 a.m. Author's Breakfast, as announced
8:00 a.m.–5:00 p.m. Registration (Mezzanine)
9:00 a.m. Session VI—Drying (I) (High Velocity Air) (Windsor North)

S. G. Holt, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., *chairman*

1. "Fundamentals of Impingement Air Drying," by C. Allander, AB Svenska Flaktfabriken, Stockholm, Sweden.
2. "Analysis of Air Impingement Drying," by S. T. Han, The Institute of Paper Chemistry, Appleton, Wis., and R. A. Doane, Stanford University, Stanford, Calif.
3. Panel Discussion "Use of High Velocity Air Impingement in Drying," (panel members to be announced).

9:00 a.m. Session VII—Maintenance (Windsor South)

H. M. Reed, Jr., International Paper Co., Mobile, Ala., *chairman*

1. "Reducing Down Time on your Recovery Unit," by C. Johnson, International Paper Co., Panama City, Fla.
2. "Planned Maintenance for Kraft Recovery Boilers," by E. L. Rivenbark, International Paper, Mobile, Ala., and C. P. Elmore, Babcock and Wilcox Co., Baberton, Ohio.
3. "Maintenance Training Programs," by H. W. Smith, St. Regis Paper Co., Jacksonville, Fla.
4. "Paper Mill Rubber Covered and Steel Roll Grinding and Maintenance Procedures," by B. B. Pierce, Crown Zellerbach, Bogalusa, La.
5. "Electric Maintenance Systems," by H. M. Reed, Jr., International Paper, Mobile, Ala., and F. J. Hrabak, Reliance Elect. & Engr. Co., Cleveland, Ohio.

12:30 p.m. Luncheons

Chemical Engineering (Essex Room)
Construction Engineering (Oxford Room)
Electrical (Dover Room)
Fluid Mechanics (French Room)

2:00 p.m. Mill Tours
2:00 p.m. Sanitary Engineering Committee (Dover Room)
4:00 p.m. Engineering Data Sheet Committee Meeting (English Room)

WEDNESDAY, OCT. 26, 1960

7:30 a.m. Author's Breakfast (as announced)
8:00 a.m.–5:00 p.m. Registration (Mezzanine)
9:00 a.m. Session VIII, Mechanical Engr. (Windsor North)

J. S. Mudgett, Strathmore Paper Co., W. Springfield, Mass., *chairman*

1. "Uniform Nip Loading Control of Machine Calenders," by J. E. Perkins, Black Clawson Co., Middletown, Ohio, and G. Luebke, Marathon Corp., Menasha, Wis.
2. "Machine Calender Roll Crowns & Pressure Distributions," by J. W. Riese, Kimberly-Clark Corp., Neenah, Wis.
3. "Mechanical Design and Installation Requirements of Trailing Blade Coater Equipment," by J. P. Munton, Rice Barton Corp., Worcester, Mass.
4. "Presentation of Data Sheet on Vacuum Requirements and Suggested Standards For Measuring Vacuum," by A. Taska, Clark & Vicario Corp., North Tarrytown, N. Y.

9:00 a.m. Session IX, Construction Engineering (Windsor South)

William Pittam, Stone & Webster Engineering Co., Toledo, Ore., *chairman*

1. "Outfall Lines into Large Bodies of Water," by W. Pittam, Stone & Webster Engineering Co., Toledo, Ore.
2. "Design of Machinery Foundations," by W. Swiger.
3. "Symposium on Construction Problems," (panel to be announced).

9:00 a.m. Session X—Drying (II) Radiant Drying (Essex, Dover, Oxford Rooms)

R. C. Swaney, Carlisle, Pa., *chairman*

Panel Discussion: "The Use of Radiant Heat for Drying."
"Technical Aspects of Radiant and Infra Red Energy," by F. J. Prince, Perfection Div. of Hupp Corp., Cleveland, Ohio.
"Theory of Radiant Heat Drying of Paper," by E. S. Mack, Asheville, N. C.
"Applications of Radiant Heat Drying of Paper," by O. Wagner, Perfection Div. of Hupp Corp., Cleveland, Ohio.

12:30 p.m. Luncheons

Steam & Power (Spanish Room)
Industrial Engineering (French Room)
Corrosion (Banquet Hall of Geo. Washington Hotel)
Operations & Research (English Room)

Bigger Sales...

- No decrease in tensile strength
- Increased cross-directional tensile strength
- No effect on colors
- Rewetting properties are unaffected

Better Production...

- Machine speeds maintained or increased
- Smoother running machines — less down time
- Will not yellow or develop odors on ageing
- Will not foam or froth in use

CELLOLUBE® Q-2

Quaternary Ammonium Paper Softener

ellolube Q-2 softens napkins, tissue and towel stocks *ithout adverse effect on physical properties* — puts added soft sell" in the finished product . . . without creating rocessing problems. And Cellolube Q-2 gives you wider ıtitude in pulp selection too! Sheets leave the doctor blade ıore uniformly, with a finer crepe. And machines actually un more smoothly with less down time. For a revelation in uperior paper softening test Cellolube Q-2 now!

conomical Cellolube Q-2 treats tissue stock for as little s $1.33 per ton, and toweling for $3.30 per ton. Increased rocessing speeds may actually lower your over-all costs! anatex is prepared to demonstrate Cellolube Q-2 in your ill on a full scale trial. For details write, wire, phone:

TANATEX CHEMICAL
CORPORATION
Belleville Turnpike, Kearny, New Jersey
WYman 8-0732

CHEMICALS
FOR DIFFICULT PROCESSING

2:00 p m. Session XI—Engineering Economics (Windsor North)

George W. Sargent, Jr., Mercury Engr., Milwaukee, Wis., *chairman*

1. "Realistic Budget Control for Large Scale Contracts," by J. G. Nagro, M. W. Kellogg Co., New York, N. Y.
2. "Economics of Moisture Control," by A. Smiley, Electric Eye Equip. Co., Danville, Ill.

2:00 p.m. Session XII—Sanitary Engineering (Dover Room)

W. A. Moggio, Lake States Yeast & Chem. Div., St. Regis Paper Co., Rhinelander, Wis., *chairman*

1. "Water Conservation and Re-Use in Industry," by Richard D. Hoak, Mellon Institute, Pittsburgh, Pa.
2. "Decolorization of Water with Special Reference to the Pulp and Paper Industry," by S. T. Powell and L. G. von Lossberg, S. T. Powell & Assoc., Baltimore, Md.

2:00 p.m. Session XIII—Fluid Mechanics (II) (Windsor South)

C. A. Lee, Formex Co. Div. of F. C. Huyck & Sons, Knoxville, Tenn., *chairman*

1. "Unsteady Flow Due to Wire Shake," by A. C. Spengos, Scott Paper Co., Chester, Pa.
2. "Function of FLO-Vac Rotary Suction Box on Fourdrinier Machines," by V. C. Hill and C. L. Clark, Clark & Vicario Corp., North Tarrytown, N. Y.
3. Final Report on TAPPI Project No. 156, "Free Surface Instability," by C. S. Yih and W. R. Debler, University of Michigan, Ann Arbor, Mich.
4. "Friction Loss of Paper Stock Through Pipe Fittings," by K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y.

6:30–7:30 p.m. Hospitality Hour (George Washington Auditorium)

7:30 p.m. Banquet. (Speaker to be announced.) (Windsor South, Windsor North, Essex, Dover, and Oxford Rooms)

THURSDAY, OCT. 27, 1960

7:30 a.m. Author's Breakfast (as announced)

8:00–5:00 p.m. Registration (Mezzanine)

9:00 a.m. Session XIV—Steam & Power (Windsor North)

H. R. Emery, St. Regis Paper Co., Jacksonville, Fla., *chairman*

1. "Water Treatment for Boilers Operating in the 600–1250 Lb. Range with High Make-up," by Limon, Graver Water Conditioning Co., New York, N. Y., R. A. Dando, St. Regis Paper Co., Deferiet, N. Y.

Panel: 1. "Training of Power Plant Personnel," T. F. Woodward, Scott Paper Co., Detroit, Mich., *moderator*

Panel Members. M. S. Ginter, Dow Chemical Co., Midland. Mich., R. M. Van Duzer, Detroit Edison, Detroit, Mich., and J. W. Herrington, Buckeye Cellulose Corp., Foley, Fla.

9:00 a.m. Session XV—Corrosion—(I) (Windsor South)

E. W. Hopper, Pittsburgh, Pa., *chairman*

1. "Ductile Iron for the Pulp and Paper Industry," by E. G. Holmberg, International Nickel Co., Inc., New York, N. Y.
2. "Plastics and Plastic Films," by R. E. Gackenbach, American Cyanamid Co., New York, N. Y.
3. "Materials of Construction for a Bleached Sulfate Mill," by J. M. Jopp, Columbia Cellulose Co., Ltd., Vancouver, B. C.
4. "Good Fabricating Practices," author, to be announced.

9:00 a.m. Session XVI—Industrial (Essex, Dover and Oxford Rooms)

1. "Storage and Handling of Clay," by H. A. Stoess, Jr., Fuller Co., Catasauqua, Pa.
2. "New Concepts for Automated Roll Handling," by S. Sundahl and C. H. Eithel, Union Bag Camp Paper Co., Savannah, Ga.
3. "Sheet Finishing," by R. Carter, Crown Zellerbach Corp., West Linn, Ore.

2:00 p.m. Session XVII—Processes Instrumentation (Windsor North)

J. K. Powell, Bowaters Southern Paper Co., Calhoun, Tenn., *chairman*

1. "The Principles of On the Machine Moisture Measuring Systems," TAPPI Project No. 775, by R. B. Hurn, Beloit Iron Works, Beloit, Wis.
2. "Then and Now, Pulp and Paper Control and Measurements, 1906 to 1960," by E. J. Trimbey, Trimbey Machines, Inc., Glens Falls, N. Y.
3. "The Outlook of the Control Engineer," by D. P. Michel, The Bauer Bros. Co., Springfield, Ohio.
4. "Interim Report-Project No. 692—Organization and Importance of the Paper Mill Instrument Dept.," Author to be announced.

2:00 p.m. Session XVIII—Corrosion (II) (Windsor South)

E. W. Hopper, Pittsburgh, Pa., *chairman*

1. "Manufacture and Testing of Stainless Tubing for Kraft Evaporating Service," to be announced.
2. "Regional Report on Alkaline Digester Corrosion," by H. M. Canavan, Mutual Boiler & Machinery Insurance Co., Waltham, Mass.
3. "Open Discussion on Overlay," Panel to be announced.

6:00 p.m. Engineering Division Staff Dinner (Essex and Dover Rooms)

Ladies Headquarters, Sunday through Thursday. Executive Suite (Room 502)

Tenth Corrugated Containers Conference

The 10th Corrugated Containers Conference is scheduled for Oct. 10–13, 1960, at the Royal York Hotel in Toronto, Ont., Canada. This conference is jointly sponsored by TAPPI and the Technical Section, CPPA, and is the first such conference to be held in Canada.

R. W. Buttery, Bathurst Containers, Ltd., Montreal, Que., is the general conference chairman and also is chairman of the TAPPI Corrugated Containers Division Production Committee.

The conference program as announced by Mr. Buttery is as follows:

SUNDAY, OCT. 9, 1960

1:00 p.m.–9:00 p.m. Welcome Lounge (British Columbia Room)

MONDAY, OCT. 10, 1960

9:00 a.m.–8:00 p.m. Registration (Room B)

9:00 a.m. Steering and Advisory Committee (Saskatchewan Room)

9:00 a.m. Production Committee (Prince Edward Island Room)

2:00 p.m. Engineering Committee (New Brunswick Room)

Industrial Engineering Committee (Newfoundland Room)

Production Committee (Prince Edward Island Room)

2:00 p.m. Quality and Process Control Committee (Algonquin Room)

340 TONS PER DAY

...MgO Plant On Line At Alaska Lumber & Pulp, Sitka

With the start of the 340 ton per day Alaska Lumber & Pulp Company plant, over 650,000 tons of pulp per year are being produced by the MgO Process.

This is the second* magnesia bi-sulfite dissolving pulp mill in Alaska, and the largest industrial improvement since statehood. Utilizing the commercially-proved, closed cycle MgO Recovery Process, Sitka's predicted chemical usage is 20 lb of MgO and 50 lb of sulfur per ton of unbleached pulp.

Two B&W recovery boilers, each designed to process 550,000 lb of waste sulfite liquor solids per day, generate a combined total of 228,000 lb of steam per hour. Two B&W power boilers provide supplemental steam for power and process to 320,000 lb per hour burning bark or oil singly or in combination.

The MgO Process provides economical recovery of chemicals and heat from the waste sulfite liquors. In addition, air pollution and process odors are reduced to an absolute minimum. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

Sitka *is the fifth MgO plant built in recent years in the continental U. S. Others are Weyerhaeuser Timber Company, Longview, Washington; Ketchikan Pulp Company, Ketchikan, Alaska; Weyerhaeuser Timber Company, Cosmopolis, Washington; Brown Company, Berlin, New Hampshire. A sixth plant is on order for Hylte Bruks in Sweden.*

P-826

B&W

THE BABCOCK & WILCOX COMPANY

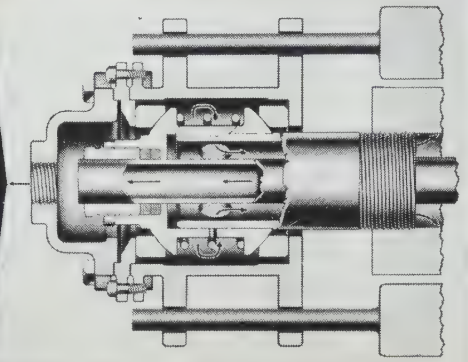
BOILER DIVISION

For High Speed Paper Machines with Revolving Syphon Pipes

In the Type LN Johnson Joints the revolving syphon pipe is made a part of the rotating assembly, yet is permitted longitudinal movement. Sealing is still accomplished without packing. Simple support rods carry all the weight of joint and connections, permit the rotating assembly to "float" freely inside. Special hangers and brackets adapt the mounting for machines with either open or enclosed gearing.

Johnson Joints fit all needs on paper machines, calenders, corrugators, waxers, embossers, roofing machines, printing presses. For full data on Type LN write for Bulletin N-2002.

Type LN Johnson ROTARY PRESSURE Joints "First in the paper industry"



THE JOHNSON CORPORATION
843 Wood St., Three Rivers, Michigan

Raw Materials Committee (Alberta Room)
Container Testing (Nova Scotia Room)

TUESDAY, OCT. 11, 1960

8:00 a.m.–5:00 p.m. Registration (Room B)
9:00 a.m. Session I (Concert Hall). "Printing on Corrugated Board"

D. M. Davis, Hercules Box Co., Columbus, Ohio, *moderator*

1. "Printing Press Rollers Designed for Corrugated Printing," by G. A. Browne, Permaflex Industries, Ltd., Toronto, Ont.
2. "Printing Inks for Corrugated Board," by R. Reid, General Printing Ink Co., Cincinnati, Ohio.
3. "Printing Dies for Corrugated Board," by H. Devon, Jas. A. Matthews & Co., Pittsburgh, Pa.

12:30 p.m. Luncheon (Canadian Room)
2:00 p.m. Session II (Concert Hall). "Printing on Corrugated Board" (Contd.)

D. M. Davis, *moderator*

1. A moving picture will be shown demonstrating the proper adjustments of printing press rollers, printing inks, and printing dies and their use to obtain top quality and to reduce costs.
2. Panel discussion on the morning and afternoon theme "Printing on Corrugated Board."

WEDNESDAY, OCT. 12, 1960

8:00 a.m.–2:00 p.m. Registration (Room B)
9:00 a.m. Session III (Concert Hall). "New Developments in Packaging"

H. J. Ostrowski, Hinde & Dauch, Ltd., Toronto, Ont., *moderator*

1. "Corrugated Containers Under Refrigeration," by A. C. Beardsell, Cincinnati, Ohio.
2. "Bulk Packaging," by T. C. Kitchell, Union Bag-Camp Paper Corp., New York, N. Y.
3. "Dynamic Testing of Corrugated Packages," by J. Turk, Glass Containers Manufacturers Institute.
4. "Underwater Beam Strength Tests for Waxed Corrugated Board," by A. C. Smith, Atlantic Refining Co., Philadelphia, Pa.

12:30 p.m. Luncheon (Canadian Room)
2:00 p.m. Session IV. General (Concert Hall)

Moderator (to be announced)

1. "The Bathurst Method for Determination of Corrugator Starch Consumption," by J. G. Reynolds, Bathurst Containers, Ltd., Montreal, Que., Can. (two additional papers to be announced).

5:00 p.m.–7:00 p.m. Reception (Canadian Room)

THURSDAY, OCT. 13, 1960

8:30 a.m. Mill tours to the following three modern corrugated container plants

1. Hinde & Dauch, Ltd., Etobicoke, Ont.
2. Bathurst Containers, Ltd., Hamilton, Ont.
3. Hygrade Containers, Ltd., Rexdale, Ont.

Lunch will be served at Brant Inn in Burlington, Ont., after the Hinde and Dauch tour, located on the shore of Lake Ontario.

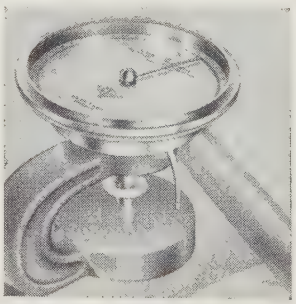
Those wishing to secure hotel reservations for the conference are urged to write promptly to: Tenth Corrugated Containers Conference, Royal York Hotel, Toronto, Ont., and state time and date of both arrival and departure.

Bursting Strength Testers • Portable, Desk, & Laboratory Micrometers • Basis Weight Scales for Papers and Tissues

Quality Control Testers for Paper and Boards

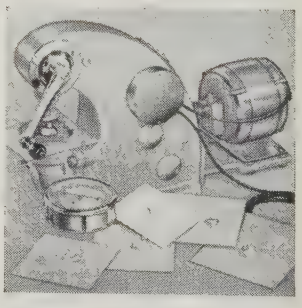
Cady Testing Instruments have a record of performance in Offices and Laboratories, throughout the Paper & Board trade for 30 Years. We can supply stock model testers, or we can build units to your specifications. To keep your testing facilities up to date, investigate the complete line of Cady Instruments. Repair Service is available if your present equipment needs attention.

Write for Complete Catalog & Price List

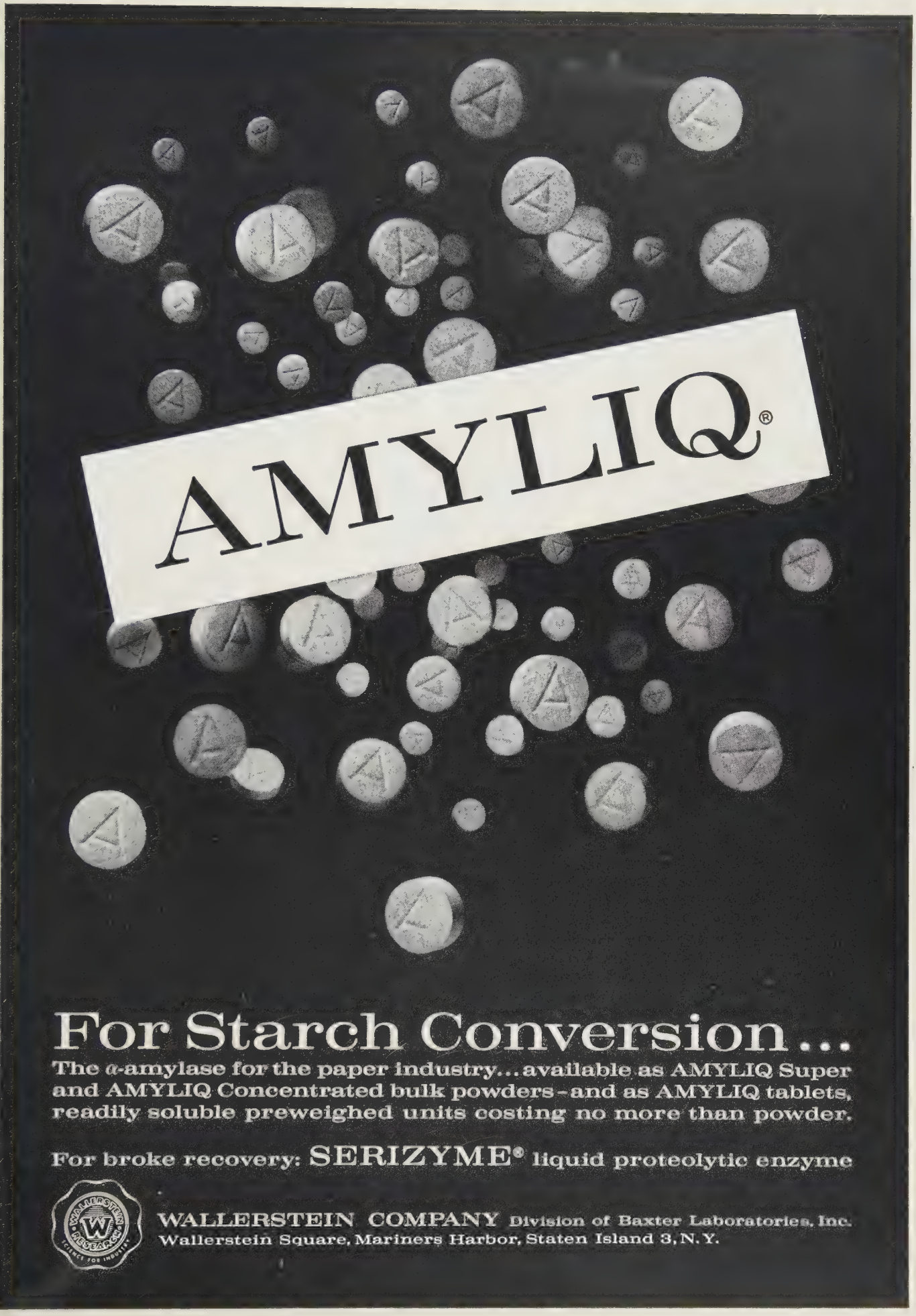


New Micrometer shown at left calipers to 10/1000 ths of an inch

Micrometers available with Carbide Tipped Anvils



E. J. CADY & COMPANY • MANUFACTURERS • 638 NORTH HARLEM • RIVER FOREST, ILLINOIS



For Starch Conversion...

The α-amylase for the paper industry... available as AMYLIQ Super and AMYLIQ Concentrated bulk powders – and as AMYLIQ tablets, readily soluble preweighed units costing no more than powder.

For broke recovery: SERIZYME® liquid proteolytic enzyme

WALLERSTEIN COMPANY Division of Baxter Laboratories, Inc.
Wallerstein Square, Mariners Harbor, Staten Island 3, N.Y.

TAPPI NOTES

The TAPPI Yearbook

Very shortly after you read these words, the 1960–1961 Technical Association Yearbook will be reaching you. This Yearbook is the 27th in a series going back to 1932, when the directory of members and other official TAPPI information were combined in one volume. The book, like a good almanac, offers much in the way of valuable information to the discerning reader.

The major portion of the Yearbook is devoted to the directory of members, which contains a complete list of TAPPI members compiled through April 30, 1960. This is divided into four parts consisting of an alphabetical list of all members and company representatives, a list of corporate members, a list of sustaining members, and a geographical roster of individual and company members. Under the alphabetical list are given the member's name, class of membership, date of membership, job title, company affiliation, and mailing address. *When you receive your new Yearbook, we would appreciate your checking to see that this information is correct and that your correct location is given in the geographical roster. If the information is incorrect, please advise us* at 360 Lexington Ave., New York 17, N. Y.

From the inception of TAPPI, this directory was published in *Technical Association Papers*, which appeared yearly, and this practice continued until 1931. In that year, a separate bound directory of members was issued, and in 1932 the Yearbook assumed its present form. The sections added in 1932 and subsequent years help make the Yearbook the "Bible" of the Association and greatly enhance its value as a reference book.

The past officers of the Association and the current officers and Executive Committee are listed first in the book. The national staff, with its various responsibilities, is also indicated. Next follows a brief statement concerning the history of the Association. Winners of the TAPPI Medal Award are indicated as part of this record.

The Association division and committee personnel are listed in a special section, with a brief description of each committee's sphere of activity. Where a committee has working subcommittees, their personnel are also listed. A list of miscellaneous Association committees and delegates to other societies is also given. With these lists it is possible for interested members to contact directly those who are working in a given field.

Of further interest in this area is the complete list of authorized committee projects. Here all formal continuing activities of the technical committees are listed. As a committee undertakes a particular activity, a title is selected and a project number assigned by headquarters. By referring to this portion of the Yearbook a member can see which are the areas of current activity in any given committee.

All the local sections and districts of the Association are also listed, along with their officers. Again, this is a convenience for members wishing to make local section contacts, and it is suggested that anyone who wishes to become active in a local section contact the section secretary for further information.

Complete alphabetical, multiple entry listings of Special Reports, Standards and Suggested Methods, Routine Control Methods, and Data Sheets issued by the Association are also included in the Yearbook Thus the book serves as a valuable reference list of TAPPI publications, and it is possible to locate quickly information on a particular subject published in any of these various forms. Orders can then be addressed directly to Association headquarters, giving the exact designation of the material wanted.

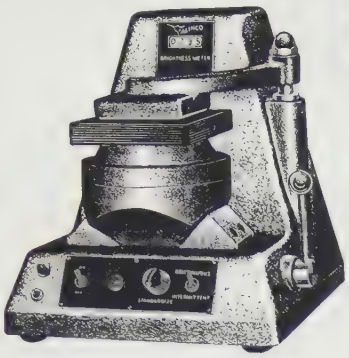
In 1949 the association established the TAPPI Fibrary, a catalog of which is included. This is a collection of various types of fiber samples and is listed in its entirety. Details for ordering samples are given.

There are three sets of important regulations in the Yearbook, which are commended for careful reading by members concerned in the areas involved. These are regulations governing standards and suggested methods, manuscripts, and project appropriations. The regulations governing manuscripts are particularly important for those preparing papers for publication.

Finally, and most important for the basic operation of the Association, the Yearbook contains the Association Constitution, Bylaws, and Code of Ethics. Reading these will give members a considerable insight into the operation of TAPPI and the professional conduct expected of the membership.

James W. Field

Another of a series of files of precision products by ALINCO



Accuracy, Standardization and Speed—ALINCO

BRIGHTNESS METER—Model 50

- SIMPLIFIED OPERATION
- STANDARDIZED READINGS
- COMPACT—LOW COST

Specially designed for use in the paper industry, this ALINCO Brightness Meter provides accurate, standardized and rapid brightness measurements. Its rugged construction and the rapidity of its readings make it particularly attractive in those plants where a great many readings are necessary. Measuring the brightness of larger areas than other commercially available instruments, the ALINCO Brightness Meter, therefore, renders readings statistically more accurate and reliable.

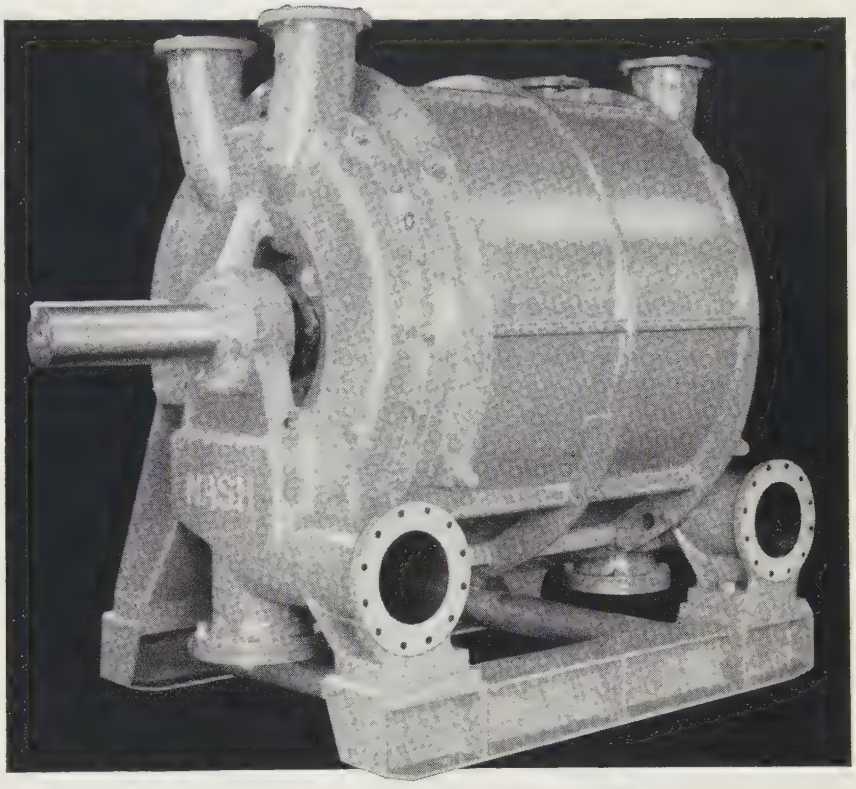
The meter is designed for operation by non-skilled personnel and incorporates special features which minimize chance for error. The reading is presented on a digital counter which eliminates interpretation by the non-skilled employee, removing the human error factor. The material to be tested is simply inserted and clamped and the reading is automatic.

For additional information on the Model 50 Brightness Meter or for the answer to your specific smoothness testing, gloss testing or bleach control problems, write:

ALINCO

Allegany Instrument Company, Inc.
Cumberland, Maryland
Palo Alto, Calif. • Washington, D. C.

Just 3 days lost production of a Paper machine can cost more than the vacuum pumps. That makes dependability the essential factor in pump selection. No pump is more dependable than a Nash



Over a thousand leading mills depend on Nash Vacuum Pumps to insure uninterrupted production. Nash Pumps are built to stand the pounding of continuous operation. They are simple. They have no internal parts in wearing contact. They will handle slugs of water or stock. They are designed to operate at the low speeds necessary for long life and reliability. Don't gamble with your production. Install Nash Vacuum Pumps and be safe.

The new Nash 5308-A shown above, has four separate suction inlets, each of which functions independently of the others. This offers the machine operator great flexibility, since these may be used in any desired combination to produce a variety of capacities and vacuums.

NASH ENGINEERING COMPANY

SOUTH NORWALK, CONN. U. S. A.

TAPPI PROFILES

John M. McEwen

JOHN M. MCEWEN, manager of the Pulp and Paper Division of the Weyerhaeuser Timber Co. in Everett, Wash., is a newly elected member of the TAPPI Executive Committee.

Born in Homer, Ill., the son of a Presbyterian minister, he received his primary education in schools in Homer; Richmond, Ind.; and Bremen, Ohio. From Bremen High School he went to Ohio State University from which he graduated in 1939 with a B.S. degree in chemical engineering. In 1941 he received an M.S. degree in chemistry from Lawrence College in Appleton, Wis., for work done at The Institute of Paper Chemistry, and upon his release from military service in 1946 he resumed his studies at the Institute and was awarded a doctorate in 1948.

While a student, John McEwen gained industrial experience in summer employment with Eastman Kodak in Rochester, N. Y., and with the Mead Corp. in Chillicothe, Ohio.

In the summer of 1941 he was called to active duty as a reserve officer in the U. S. Army Corps of Engineers, and during the war years rose to the rank of major. Most of his military experience has been with floating bridges, and he wrote or revised several army manuals on military bridging. He also served as the senior engineer R.O.T.C. instructor and assistant professor of military service and tactics at Ohio State University.

In 1947 he joined the Pulp Division Research Department of the Weyerhaeuser Co. in Longview, Wash., and in 1949 was made associate research director and transferred to Everett, Wash. One year later he was appointed technical director of the Weyerhaeuser Everett sulfite mill and in 1953 he became technical director of the Everett kraft mill.

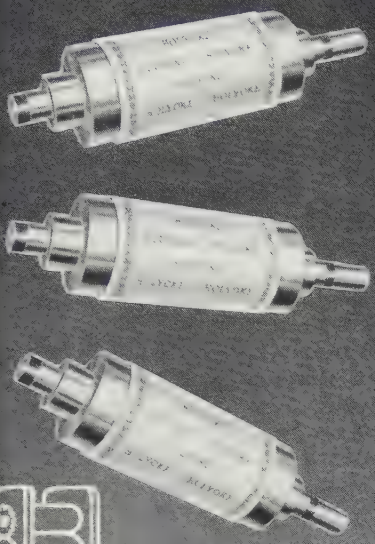
John McEwen joined TAPPI in 1941. In 1950 he became chairman of the Acid Pulping Committee. The vice-chairman of the Pacific Section of TAPPI in 1954, he was acting-chairman for the remainder of the year when the chairman was transferred to the east, and was elected chairman for the 1955 term. In 1959 he was editor of the handbook of the Pacific Section of TAPPI. This publication commemorates 30 years' existence of this TAPPI Section and gives the history of the organization. He was elected to the National Executive Committee at the Annual Meeting in February, 1960, and is now also serving on the Publications Management Committee.

He is the author of many publications in the pulp and paper field. These include articles on quality control, pulp testing, bleaching, acid pulping, raw materials, and pulpwood. At present he is working on the hypochlorite bleaching chapter of the new TAPPI Bleaching Monograph.

John McEwen also serves his community in many ways. He is an elder in the Presbyterian Church and is on the Board of Trustees of the First Presbyterian Church in Everett; he has taught Sunday School classes for many years. Married in 1942 to Isabel Ruble, and now the father of three daughters, both he and his wife are advisers to the Senior High School Youth Fellowship of their church. He himself has served on the Everett Area Boy Scout Council and is presently on the Everett Campfire Girls Executive Committee. His interest in schools is evidenced by service on the Citizens Education Advisory Committee to the Everett School Board. He has also been active in helping to establish a local and regional Science Fair in Everett. This group is now incorporated as a nonprofit organization and sends the two top winners to the National Science Fair.

Among his other interests are bridge, golf, and gardening. He is a member of the American Chemical Society, the Air Pollution Control Association, the Technical Section of the Canadian Pulp and Paper Association, and the Everett Municipal Golf Club.

"HOLYOKE" EMBOSSING ROLLS



Established 1863

Do You Have an Embossing Problem?

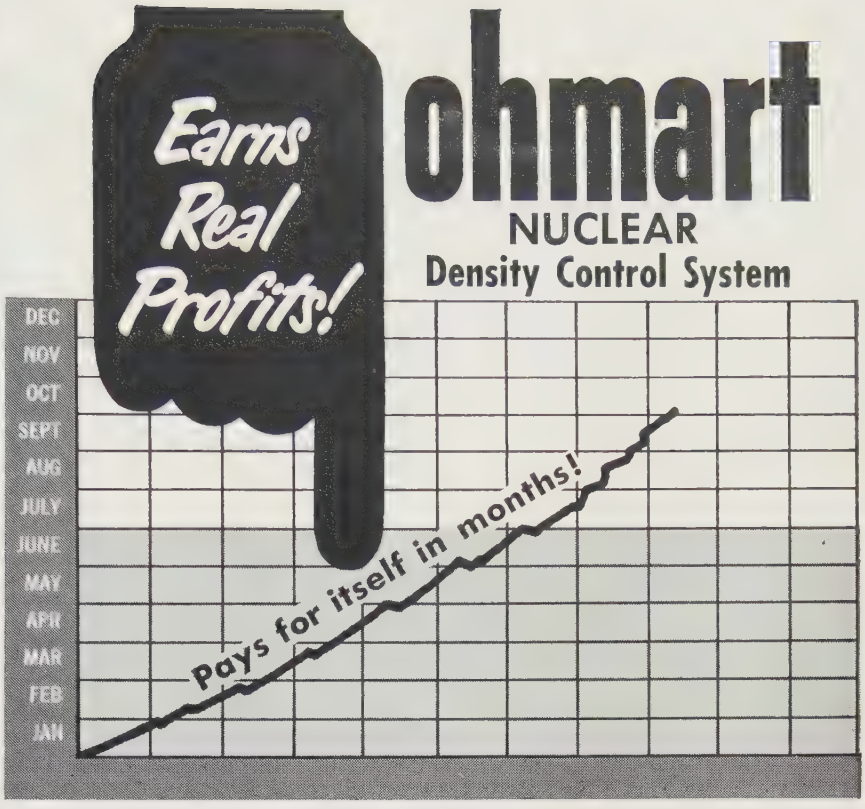
We may not know *all* the answers, but we *have* solved the problems of mills producing designs of all types, both fine and coarse. We can supply the embossing roll to meet the delivery schedule of your engraved roll. Tell us the size of your engraved roll, the pattern and material you are embossing, and we will advise the type of embossing roll to use.

"HOLYOKE" Embossing Rolls hold their pattern a long time. They are easy to "run in" and that means less machine down-time.

Correspondence Invited

HOLYOKE MACHINE COMPANY

CALENDER and EMBOSSING ROLLS
for the PAPER and TEXTILE INDUSTRIES
WATER FILTRATION EQUIPMENT
HOLYOKE, MASSACHUSETTS



ohmart NUCLEAR Density Control System

It's a fact! Ohmart Density Control Systems usually pay for themselves within six months and less, according to customer reports from many industries. One processor states that his Ohmart installation pays off its cost *twice each week* of operation.

If in your processing you use evaporators, spray dryers, drum dryers, classifiers, kilns . . . any equipment where liquid or slurry density or concentration is important . . . you can profit with Ohmart. *Its performance is guaranteed!*

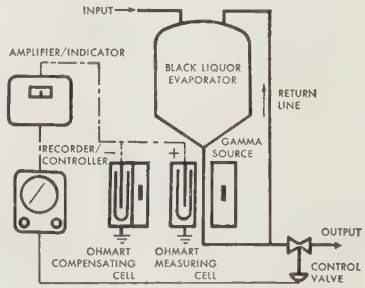
Here's how an automatic, accurate and continuous Ohmart installation can earn real profits for you:

1. Ups production . . . cuts variable and capital costs.
2. Maintains more uniform and better product . . . more output from same input.
3. Eliminates costly and inaccurate manual sampling . . . saves manpower.

Ohmart makes the most complete standard line of nuclear gaging equipment for controlling the density variable in liquids or slurries, level measurement, and interface detection. There are more Ohmart Nuclear Process Control Systems in operation than all others combined.

For Ohmart profit-earning details, write for Bulletin 105-C.

PULP AND PAPER applications for Ohmart Nuclear Density Control Systems



Concentration of black liquor in evaporator is maintained and controlled to an optimum density by use of Ohmart Model SG Nuclear Density Gage.

Some typical applications of Ohmart Control Systems

Control of—

Pulp Level in Bleaching Towers
Black Liquor Density
Chip Level
Coating Slurry Density
Green Liquor Concentration
Lime Mud Density
Digester Level

ohmart

—World Leader in Nuclear Process Control

The Ohmart Corporation
2244 Bogen St., Cincinnati 22, Ohio

Engineering representatives in principal areas

PERSONAL MENTION

New TAPPI Members

Perrin A. Allen, Jr., Paper Chemist, R. T. Vanderbilt Co., Inc., New York., N. Y., a 1956 graduate of Bowdoin College.

Ronald L. Anderson, Manager, Office and Lithograph Dept., Johnson Printing Service, De Kalb, Ill., a 1951 graduate of Northwestern University.

Giuliana Barattini, Process Products Engineer, Mobil Oil Italiana S.p.A., Genoa, Italy, a 1952 graduate of University of Genoa.

William J. Barrentine, President, Dri Dux Div., Resisto Chemical, Inc., Wilmington, Del.

Charles K. Barton, Jr., Sales Representative, Morningstar-Paisley, Inc., New York, N. Y., a 1947 graduate of Dartmouth College.

Antonio F. Bazzoni, Consulting Engineer, Milano, Italy.

Ranjit Kumar Bose, Works Manager, Indian Paper Machinery & Engineering Works (P), Ltd., Calcutta, India, a 1948 graduate of Jadavpur University.

James N. Bowersock, Technical Superintendent, North Western Pulp & Power, Ltd., Hinton, Alta., Canada, a 1956 graduate of University of Alberta.

Raymond A. Bruce, Sales Engineer, Hayden Wire Works, Inc., West Springfield, Mass.

Marion A. Buchta, Manager, Industrial Div., Gilbert Associates, Inc., Reading, Pa., a 1935 graduate of University of Nebraska.

George Chandler, City Librarian, Liverpool Public Libraries, Liverpool, England, a graduate of London University with a Ph.D. degree.

Walter Christiani, Sales Engineer, Dorr-Oliver, Inc., Oakland, Calif., a 1943 graduate of Montana State College.

John H. Clark, Vice-President, Rader Pneumatics, Inc., of Tennessee, Memphis, Tenn., a 1941 graduate of Williams College.

Erich Correns, Professor, Deutsche Akademie der Wissenschaften zu Berlin, Berlin, Germany, a 1922 graduate of Universitat Berlin with a Ph.D. degree.

Richard M. Dennany, Chemist, KVP Sutherland Paper Co., Kalamazoo, Mich., a 1959 graduate of Western Michigan University.

Harry S. Eldridge, Chief Chemist, United Paste & Glue Corp., New York, N. Y., a 1932 graduate of City College of New York.

Werner Ewert, Technologist, Shell Chemical Co., New York, N. Y., a 1952 graduate of Rutgers University.

John W. Felton, Application Engineer, Goulds Pumps, Inc., Seneca Falls, N. Y. a 1953 graduate of University of Rochester.

Lee H. Flanders, Sales, John W. Bolton & Sons, Inc., Lawrence, Mass., a 1958 graduate of Temple University.

John G. Foushee, Engineer, Chas. T. Main, Inc., Charlotte, N. C., a 1942 graduate of North Carolina State College.

Frederick R. Gardner, Supervisor, Container Testing, Hinde and Dauch, Ltd., Toronto, Ont., a 1947 graduate of Queen's University.

Chester S. Gaynes, Chief Engineer, Gaynes Engineering Co., Chicago, Ill., a 1941 graduate of Illinois Institute of Technology.

Charles H. George, Staff Assistant, Champion Celulose, S.A., Sao Paulo, Brazil, a 1952 graduate of Texas College of Arts and Industries.

David R. Gustafson, Engineer, Beloit Iron Works, Beloit Wis., a 1958 graduate of University of Maine.

Robert H. Hall. Process Engineer, Fiberboard Paper Products Corp., San Joaquin Div., Antioch, Calif., a 1954 graduate of Iowa State College.

Katsumi Harada, Testing Section, Ohtake Paper Industry Co., Ltd., a 1940 graduate of Hiroshima Technical College.

James A. Harrocks, Research Chemist, International Business Machines Corp., Endicott, N. Y., a 1953 graduate of Bowdoin College with a Ph.D. degree in 1960 from Institute of Paper Chemistry.

Derald R. Hatton, Chief Design Engineer, Shartle Div. Black-Clawson Co., Middletown, Ohio, a 1952 graduate of University of Cincinnati.

William C. Hawthorne, President, W. C. Hawthorne & Associates, Hackensack, N. J., a 1948 graduate of Purdue University.

Ole Hedalen, Mill Manager, Ankers Traesliperi & Papirfabrik A.S., Halden, Norway, a 1940 graduate of Technical University of Norway.

Albert O. Herbst, Chemical Engineer, Ford, Bacon & Davis Inc., New York, N. Y., a 1955 graduate of Oscar von Miller Polytechnic Institute.

John N. Hetherington, Librarian,, E. S. & A. Robinson Holdings, Ltd., Bristol, England. Attended Clifton College England.

Kenneth F. Hodge, Research & Development Coordinator Packaging Corp. of America, Grand Rapids, Mich., a 193[illegible] graduate of Michigan State University.

Paul T. Hoelderle, Research Chemist, Watervliet Paper Co., Watervliet, Mich., a 1960 graduate of Western Michigan University.

Clare Hume, Assistant Chief Chemist, Publishers Paper Co. Oregon City, Ore., a 1929 graduate of Oregon State College

Ronald J. E. Hunter, Chief, Research and Development Lab., Continental Can Co. of Canada, Ltd., Paper Products Div., Toronto, Ont.

Harold S. Inman, Plant Manager, Continental Can Co. of Canada, Ltd., London, Ont.

John W. Johnson, Superintendent, Woodlands Research Dept., Union Bag-Camp Paper Corp., Savannah, Ga., 1946 graduate of University of Michigan.

Thomas R. Johnson, Jr., Supervisor of Quality Control Riegel Paper Corp., Carolina Div., Acme, N. C., a 195[illegible] graduate of North Carolina State College.

Robert H. Jones, Application Engineer, Beckman Instruments, Inc., Fullerton, Calif., a 1950 graduate of Johns Hopkins University.

Gerhard Jung, Chemist, Druckfarbenfabriken Michael Huber, Munchen, Germany, a 1954 graduate of Technical University, Stuttgart with a Ph.D. degree.

Gunther Junghans, Manufacturing Chief, Polygal, Ltd. Marstetten, Switzerland, 1949 graduate of College of Technology, Winterthur.

Dean H. Kohlhepp, Engineer, Pulping & Centrifugal Cleaning, Shartle Div., Black-Clawson Co., Middletown, Ohio, a 1937 graduate of Pennsylvania State University.

Rudolf F. Kozich, Supervisor, Production Engineering Dorr-Oliver, Inc., Stamford, Conn., a 1948 graduate of Bundesgewerbeschule, Wiener, Neustadt, Austria.

Patrick C. Krohn, Sales Representative, Northeastern Paper Sales, Inc., Chicago, Ill. Attended University of Illinois.

Frank B. Loppnow, Development Engineer, Kimberly-Clark Corp., Neenah, Wis., a 1944 graduate of Marquette University.

Hans H. Mahler, Director of Research, Hygrade Containers, Ltd., Montreal, Canada.

Carl J. Malm, Director of Division, Eastman Kodak Co., Rochester, N. Y., a 1923 graduate of Abo Akademi, Finland.

Ralph H. Martin, Assistant to President, Standard Packaging Corp., New York, N. Y., a 1944 graduate of Carnegie Institute of Technology.

Paul E. Merrifield, Chemist, Armstrong Cork Co., Fulton, N. Y., a 1951 graduate of Rice Institute with a Ph.D. degree.

Frank W. Miner, Manager, Sales Development, American Cyanamid Co., New York, N. Y., a 1947 graduate of Cooper Union.

Joe B. Morrison, Project Chemist, Weyerhaeuser Co., Springfield, Ore., a 1960 graduate of Western Michigan University.

James Morton, Engineering Draughtsman, James Bertram & Sons, Ltd., Edinburgh, Scotland, a 1954 graduate of Heriot Watt College.

Anatole J. Navarre, Vice-President in charge of Manufacturing, Noralyn Paper Mills, Inc., Baton Rouge, La.

Elbert H. Neese, Jr., Assistant to President, Beloit Iron Works, Beloit, Wis., a 1944 graduate of Purdue University.

John A. S. Newman, Assistant Manager of Research & Development, Wiggins Teape & Co., Ltd., Beaconsfield, Bucks, England, a 1950 graduate of University College of S.W. England.

Constance E. Piccioni, Acquisitions Librarian, Montana State College, Bozeman, Mont.

Richard D. Quina, Plant Engineer, International Paper Co., Springhill, La., a 1948 graduate of Auburn University.

J. S. Sprinivasa Rao, Mechanical Superintendent, The Mysore Paper Mills, Ltd., Bhadravati, India, a 1936 graduate of Mysore University.

Bryan L. Rauschert, Resident Manager, Rayonier Incorporated, Fernandina Beach, Fla., a 1933 graduate of University of Washington.

Cornelius F. Reardon, Jr., Research Chemist, Print Stock Group, Mystik Adhesive Products, Inc., Northfield, Ill., a 1954 graduate of John Carroll University.

Giovanni Restivo, Production Manager, Vita Mayer & Co. Milan, Italy.

Everett J. Rinker, Superintendent, Liberty Corrugated Paper Co., Brooklyn, N. Y. Attended Fordham University.

Donald B. W. Robinson, Assistant Research Director, Bathurst Power & Paper Co., Ltd., Bathurst, N. B., a 1943 graduate of McGill University.

Peter M. Ruzevick, Director of Research, The Cromwell Paper Co., Chicago, Ill., a 1930 graduate of Armour Institute.

Wyndham F. Saunders, Mill Superintendent, Colthrop Board & Paper Mills, Ltd., Thatcham Nr. Newbury, Berks., England.

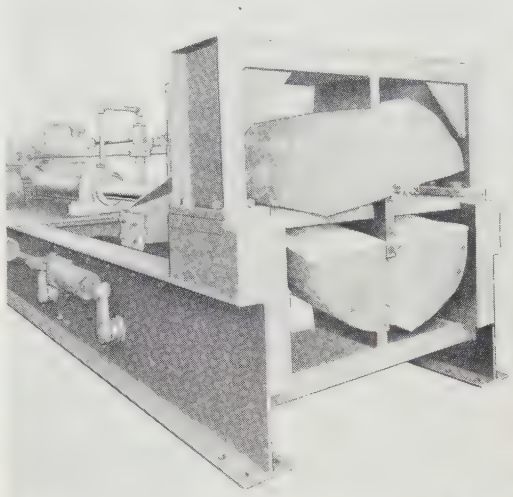
Don R. Schamp, Assistant Sales Manager, Beloit Iron Works, Beloit, Wis., a 1942 graduate of State University of Iowa.

Giuseppe Segre, Mechanical Engineer, Societa Cartiera Sibilla, Rome, Italy, a 1955 graduate of University of Pisa.

Eugene J. Semar, Sr., Paper Machine Operating Engineer, West Virginia Pulp & Paper Co., Luke, Md., a 1953 graduate of University of Delaware.

Giuseppe Sidoli, Mill Superintendent, Cartiera Vita Mayer & C., Milano, Italy, a 1940 graduate of Milan University with a Ph.D. degree.

John T. Simmons, Electrical Engineer, Bowaters Engineering and Development, Inc., Calhoun, Tenn., a 1955 graduate of University of Houston.



ONE STROKE DOES IT!

MURCO HYDRAULIC WOOD SPLITTER

- **For processing logs too large in diameter to be handled by the chipper.**
- **Capacity approximately 1 log per minute.**

The MURCO Hydraulic Wood Splitter does the job so that handling and number of operations are reduced to a minimum. It is equipped with a Star type stationary axe that quarters the wood in one stroke. Its capacity is approximately 1 log per minute (based on the calculation that it takes about thirty seconds to load the machine with the log to be split). Extremely heavy construction, this is equipment designed for heavy duty . . . base is an all-welded design from structural steel . . . axe knives are steel plate flame hardened and strongly reinforced to withstand the impact of splitting . . . cylinder and ram of heavy duty construction Typical installations — Rayonier, Inc., Doctortown, Georgia; Olin Mathieson Chemical Corp., Monroe, Louisiana; Scott Paper Co., Mobile, Alabama; Owens-Illinois, Tomahawk, Wisconsin; Container Corporation of America, Fernandina Beach, Florida; Kansas City Star Co., Park Falls, Wisconsin.

WRITE
for proposal and quotations to meet your pulpmill requirements . . . specify maximum diameter and length of wood to be split.

Overall dimensions of MURCO Hydraulic Wood Splitter for 36" diameter wood 5'3" long are 21' long x 5'2" wide, x 5'8½" high.

D. J. MURRAY MANUFACTURING CO.
Manufacturers Since 1883 WAUSAU, WISCONSIN

Frank C. Smith, Field Service Engineer, Huyck Felt Co., Rensselaer, N. Y. Attended New York State College of Forestry.

Kjell Solvberg, Technical Director, A/S Greaker Cellulosafabrik, Greaker, Norway.

Walter A. Southern. Librarian, Abbott Laboratories, North Chicago, Ill.

Joseph E. Streb, Process Engineer, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., a 1958 graduate of Western Michigan University.

Harold C. Templeton, Chief Metallurgist, Alloy Steel Products Co., Linden, N. J., a 1939 graduate of Colorado School of Mines.

Gian Paolo Torri, Director, Cartiera Aquila S.r.l., Milan, Italy.

Wallace R. Wood, Research Engineer, Scott Paper Co., Everett, Wash., a 1951 graduate of University of Washington.

Ernst W. Zwick, Salesman, Riordon Sales Corp., Ltd., New York, N. Y. Attended Dartmouth College.

Appointments

Lyman C. Aldrich, formerly of The West Virginia Pulp & Paper Co., is now Supervisor of Technical Service to the kraft pulp and paper mills, St. Regis Paper Co., Carthage, N. Y.

William E. Anderson, Jr. is now Manager of Converting and Coating for The Riegel Paper Corp., Milford, N. J.

Harold W. Anway, Jr., District Sales Manager of The Monsanto Chemical Co., Organic Chemicals Division has been transferred from San Francisco, Calif., to Atlanta, Ga.

Ernest F. Barker is now European Editor of the *Paper Trade Journal,* Monte Carlo, Monaco.

Justus C. Barthel, formerly of the American Cyanamid Co., is now General Manager of the Bondware Division Research and Development, Continental Can Co., Chicago, Ill.

John C. Becker, Jr., formerly of The Celanese Corp. of America, is now Assistant Technical Service Manager of the Polyco-Monomer Dept. of Borden Chemical Co., Leominster, Mass.

John S. Buchaven is now Assistant Kraft Mill Superintendent of The Nekoosa-Edwards Paper Co., Port Edwards, Wis.

Louis R. Busche, formerly Student at The Institute of Paper Chemistry, is now in the research department of John A. Manning Paper Co., Inc., Troy, N. Y.

Harry K. Collinge is now Vice-President of North Western Pulp & Power Co., Hinton, Alt., Canada.

William F. Connolly, formerly of Congoleum-Nairn Co., is now a Paper Technologist in the Stored-Product Insects Branch of the U. S. Department of Agriculture, Savannah, Ga.

Harold G. Cook, formerly of Arnold, Hoffman & Co., Inc., is now a Chemist with The Imperial Chemical Industries Ltd., Dyestuffs Division, Blackley, Manchester, England.

Joseph P. Corbin, of the St. Regis Paper Co., has been transferred from Jacksonville, Fla., to Deferiet, N. Y., as Assistant Manager of the Printing and Publication Division.

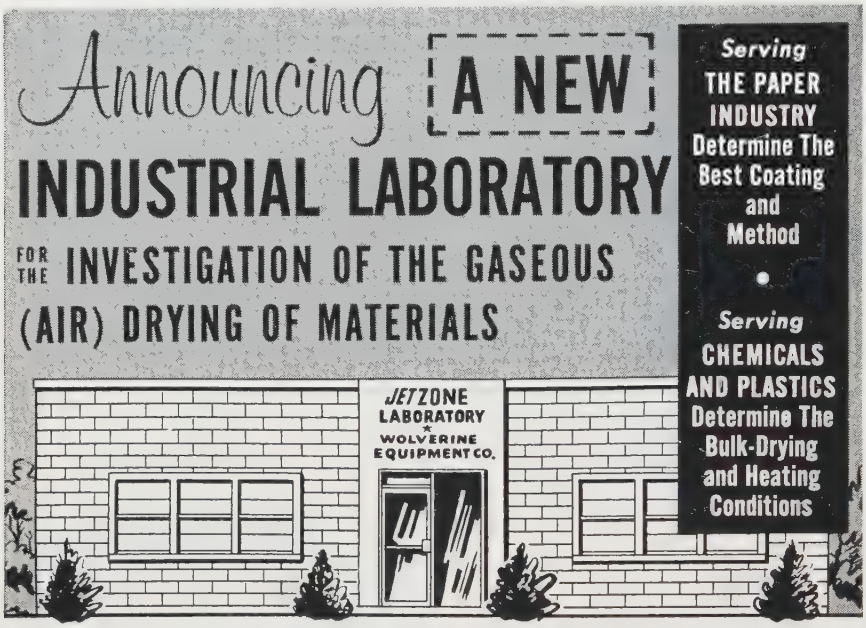
John R. Cramsie, formerly of Bathurst Power & Paper Co., Ltd., is now a Materials Specialist for St. Regis Paper Co., Carthage, N. Y.

H. Lance Crosby, formerly of Dorr-Oliver Co., is now in the contract sales department of the M. W. Kellogg Co., New York, N. Y.

Arthur J. Dimick is now Executive Vice-President of The Columbia Box Board Mills, Chatham, N. Y.

Robert W. Doe, of the West Virginia Pulp & Paper Co., has been transferred from Mechanicsville, N. Y., to Luke, Md., as Pulp Mill Superintendent.

Carmin P. Donofrio, formerly Professor at The New York State College


Announcing A NEW
INDUSTRIAL LABORATORY
FOR THE INVESTIGATION OF THE GASEOUS (AIR) DRYING OF MATERIALS
Serving THE PAPER INDUSTRY Determine The Best Coating and Method
Serving CHEMICALS AND PLASTICS Determine The Bulk-Drying and Heating Conditions
JETZONE LABORATORY
WOLVERINE EQUIPMENT CO.

Three Pilot Lines

LINE 1 A Universal 3-Zone Conveyerized Oven — Interchangeable air projection plates above and below — Temperature 70-600° — Low and high velocity 400-10,000 ft. per min. — 24″ wide conveyor with wide range drive — All zones individually retractable from conveyor line — Steam injection for humidity control all zones — Zoned horizontally as well as vertically.

Purpose: Drying and curing of wet material — Coated webs, coated objects, plastics, impregnated webs, etc. — Arranged for quick determinations on all products by the "Miniaturized" sample car method.

Preceded by: Coater, impregnating tanks and squeeze rolls.

LINE 2 Two Zone Dryer, Heater or Cooler for Particulate Matter (pelletized material — chopped material — crystals). Works by aerating a bed of material on belt conveyor — Velocity range 1000-10,000 ft. per min. — Temperature 45°-600° — Arranged for separation of fines — 12″ wide belt conveyor.

Purpose: Drying, heating, cooling of particles of material.

Preceded by: Feeder or pelletizer.

LINE 3 Super Speed High Velocity 4-Zone Arch Dryer for Coated Web Material — Carries 24″ web on rolls or belt — Velocity 400-12,000 ft. per min. — Temperature 70-600°F — Proved drying capacity (clay latex) 2800 ft. per min.

Purpose: Proving coatings and coating methods.

Preceded by: Coaters by different manufacturers.

Plus — Precision Batch Dryer — Basis Weight Scales, Thermocouples, Thermometer, Mixing Equipment, Etc.

Write for terms and advance reservation. Please include description of product and scope of investigation required. Clients are not expected to be customers of our other divisions. Reports and samples are the exclusive property of the client.

"TAKING THE MYSTERY OUT OF DRYING"
WOLVERINE EQUIPMENT COMPANY
31 MAIN ST., CAMBRIDGE 42, MASS.

JETZONE LABORATORY DIV.

A LEADER IN HIGH VELOCITY DRYING SINCE 1946

of Forestry, is now Manager of Pulping Research for The Champion Paper & Fibre Co., Hamilton, Ohio.

Leslie S. Congal, formerly of Tasman Pulp & Paper Co., Ltd., is now General Manager of The Imperial Paper Mills, Ltd., Gravesend, Kent, England.

William E. Driscoll of The Borden Chemical Co. has been transferred from New York, N. Y., to Elmhurst, Ill., as Midwest District Sales Manager.

Donald J. Guillet, formerly of The Sorg Paper Co., is now a Technical Sales Service Engineer for The Huyck Felt Co., Rensselaer, N. Y.

William W. Fitzhugh, Jr., formerly of William W. Fitzhugh, Inc., is now President of The New Haven Board & Carton Co., New York, N. Y.

Uno G. Fryklund, formerly of Stocklholm, Sweden, is now Technical Adviser of the Gwalior Rayon Silk Mfg. Co., Ltd., Wood Pulp Division, Kozhikode (Kerda) India.

James J. Harrison, formerly of Michigan Carton Co., is now New England Regional Manager of The Federal Paperboard Co., New Haven, Conn.

Manne Helgegren, formerly of West Virginia Pulp & Paper Co., is now a Project Engineer for Bowaters Engineering & Development, Inc., Calhoun, Tenn.

Robert R. Howarth is now President of The Columbia Box Board Mills, Chatham, N. Y.

John H. Kuhn, of The Container Corp. of America, has been transferred from Philadelphia, Pa., to Chattanooga, Tenn., as Plant Superintendent.

Chester G. Landes, formerly of Wica Chemicals, Inc., is now a Consultant in Charlotte, N. C.

Russell J. Le Roux is now Manager of Manufacturing of The Weyerhaeuser Timber Co., Pulp and Paperboard Division, Tacoma, Wash.

H. Clark Lind, formerly of Texon, Inc., is now a Research Engineer for Huyck Felt Co., Rensselaer, N. Y.

R. J. Lodge is now General Manager of The Borden Chemical Co., New York, N. Y.

Daniel A. Martinez is now Converting Manager of The Hudson Pulp & Paper Corp., Palatka, Fla.

Peter J. Metz, of The Crown Zellerbach Corp., has been transferred from Orange, Tex., to San Francisco, Calif., as Project Manager in the Packaging Division.

Thomas E. Mills, formerly Student at Lowell Technological Institute, is now in the U. S. Air Force, Lowry Base, Colo.

Henry Z. Mohrer, formerly of The Old Town Corp., is now Production Manager for the Federal Paper Board Co., Inc., Montville, Conn.

Edwin G. Paulson, formerly of The Brandon Paper Mills, Inc., is now a Staff Engineer with Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

Lester L. R. Phillips, formerly of The Hurlbut Paper Co., is now Assistant Sales Manager for Mead Packaging, Los Angeles, Calif.

Charles J. Prawdzik, formerly of Interstate Container Corp., is now District Production Manager for The St. Regis Paper Co., Cleveland, Ohio.

George H. Rand is now Vice-President and Manager of Manufacturing of The International Paper Co., New York, N. Y.

Arthur R. Root, Jr., formerly of Champion Paper & Fibre Co., is now Process Control Chemical Engineer for The Moraine Paper Co., W. Carrollton, Ohio.

James J. Ross, formerly of Millspaugh (Canada), Ltd., now President of Extremultus Transmissions, Ltd. and Acme Chain & Gear, Ltd., Lachine, P. Q.

John E. B. Sawyer, formerly of Columbia Cellulose, Ltd., is now Plant Engineer for Celgar, Ltd., Vancouver, B. C.

Ernst H. Schaefer, of The West Virginia Pulp & Paper Co., has been transferred from Covington, Va., to Mechanicsville, N. Y., as a Research Project Leader.

John J. Steinbinder is now Manager of converting and coating for the Riegel Paper Corp., Milford, N. J.

Ernst G. Steinhauer, formerly of Beloit Iron Works, is now Assistant Export Manager for E. D. Jones Corp., Pittsfield, Mass.

Kenneth Thompson, formerly of Lowe Paper Co., is now with Champion Paper & Fibre Co., Hamilton, Ohio.

Maunsell C. Wakefield, formerly of Titanium Pigment Co., is now Sales Manager for the Polyco-Monomer Department of Borden Chemical Co., New York, N. Y.

Ralph A. Wilkins is now President of Bird & Son, Inc., East Walpole, Mass.

Edwin S. Worden is now Executive Vice-President of Edgar Steiner & Co., New York, N. Y.

* * *

Allan F. Kane has succeeded *Charles M. Koon* as the corporate representative of The Eastern Fine Paper & Pulp Division of Standard Packaging Co., Brewer, Me., in the Technical Association.

L. G. Janett, Vice-President and General Manager, has succeeded *S. W. Fletcher,* retired as the official representative of J. O. Ross Engineering Division, Midland-Ross Corp., Mt. Prospect, Ill., in TAPPI.

W. R. Moffitt, Vice-President and Technical Director, has succeeded *W. J. Roider* as the official representative of The Borden Chemical Co., New York, N. Y., in the Technical Association.

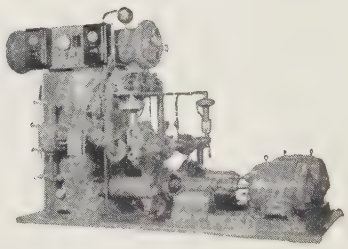
Eleventh Testing Conference

TAPPI

Pantlind Hotel, Grand Rapids, Mich.

Sept. 27–29, 1960

The ONE Vacuum Pump Made for Paper Mills



The Stickle Vacuum Pump is made exclusively for paper mills. It's easy to service. All floats housed in exterior float boxes. Interchangeable, removable vacuum chamber is above tank. Inspection of ejector tubes may be made without moving motor, pump or piping. Uses standard horizontal motor and pump. For vacuums to 28″. Built-in heat exchanger eliminates costly cooling equipment. Recirculation of hurling water condenses flash vapors and releases air and gases to atmosphere. No close clearances to cause wear. Performance guaranteed. Single and duplex models. Write for free literature.

STICKLE STEAM SPECIALTIES COMPANY

2209 Valley Ave. • Indianapolis 18, Ind.

Moisture Control Systems
Dryer Drainage Systems
Feed Water Heaters
Vacuum Pumps
Micro Adjustable Orifices
Differential Control Valves

INDUSTRY NOTES

North American

Statistics*

Paper and Paperboard Production

Paper and paperboard production for the first quarter of 1960 is estimated at 8.8 million tons. This is an increase of 8% above production for the first quarter of 1959. Paper production totaled about 3.9 million tons in the three month period, an increase of 10%; paperboard production amounted to about 4.1 million tons, an increase of 6%; construction paper and board totaled 779 thousand tons, an increase of 3%.

Pulpwood

Total receipts of pulpwood for January-February, 1960, were 6,980,000 cords, an increase of 801,000 cords over receipts for the comparable period last year. Domestic receipts were 708,000 cords above the year earlier total, and imports increased 93,000 cords. All of the regions showed increases ranging from 10% in the Northeast to 24% in the West.

Pulpwood consumption for January-February, 1960, was 6,661,000 cords, an increase of 538,000 cords over the same period of 1959. All of the regions showed increases ranging from 5% Northeast to 25% North Central.

Inventories of pulpwood at the end of February were 5,483,000 cords, an increase of 135,000 cords above January, 1960; and a 487,000 cord decline from February, 1960. All of the regions showed decreases ranging from 4% South Atlantic to 14% Northeast.

Wastepaper and Other Fibrous Materials

February wastepaper receipts were 737,000 tons; for the first two months of this year they totaled 1,562,000 tons, an increase of 89,000 tons above receipts for last year.

Wastepaper consumption for February was 756,000 tons; the January-February total was 1,495,000 tons, an increase of 36,000 tons above consumption for the same period last year.

Inventories at the end of February were 556,000 tons, a decrease of 18,000 tons below January, and an increase of 107,000 tons above inventories at the end of February, 1959.

Consumption of total fibrous materials for February was 838,000 tons; the January-February total was 1,659,000 tons, an increase of 34,000 tons above consumption for the comparable period last year.

Inventories of total fibrous materials at the end of February were 1,022,000 tons, 45,000 tons below January and 85,000 tons above inventories at the end of January, 1959.

Wood Pulp

Production of wood pulp for January-February, 1960, was 4,145,000 tons, an increase of 342,000 tons above the comparable 1959 total.

Wood pulp consumption in the manufacture of paper and board for January-February, 1960, was 4,262,000 tons, an increase of 331,000 tons above consumption for the same period last year.

Imports of wood pulp for January-February, 1960, were 387,230 tons, a decrease of 4% below imports for last year. Imports from Canada for January-February, 1960, were 307,478 tons, a decrease of 3% below the comparable period of 1959. Overseas imports for January-February, 1960, were 72,011 tons as compared to 85,023 tons for the same period last year.

Exports of wood pulp for January-February, 1960, were 119,400 tons, as against 94,037 tons exported during the same period last year.

Inventories of wood pulp at paper and board mills at the end of February were 505,000 tons, a decrease of 19,000 tons below inventories at the end of January and 44,000 tons below inventories at the end of February, 1959.

* American Paper and Pulp Association, *Monthly Statistical Summary* XXXVIII, No. 5: May, 1960.

Overseas

Argentina

New Phenol Plant to Be Built

A new phenol plant will be built in Argentina as the result of a loan by the Export-Import Bank of Washington, D. C. The loan will be used entirely for purchase in the United States of various chemical equipment required by Duranor, Industrial Quimicas Sociedad Anonima Industrial y Comercial for this plant which will have a capacity of 25 metric tons of phenol per day. The total multimillion-dollar plant investment, including buildings, other equipment, and land, considerably exceeds the amount of the loan.

Duranor was recently formed by Atanor, Compania Nacional para la Industria Quimica and Hooker Chemical Corp. Both companies are large manufacturers of chemicals and plastics. Atanor, headquartered in Buenos Aires, Argentina, has plants at Munro, a suburb of Buenos Aires, and Rio Tercero, Argentina, while Hooker, headquartered in New York City, has 13 plants in the United States, Canada, and Mexico.

Brazil

Cameron do Brasil, Ltda.

Cameron Machine Co., Dover, N. J., has announced the formation of a subsidiary company, Cameron do Brasil Industria e Comercio, Ltda. The new company with main offices at Rua 24 de Maio 104, Sao Paulo, will manufacture and distribute Cameron slitting and roll winding machines and auxiliary roll production equipment. Production is now under way for the cameron Model 550 duplex center winder and the Model 400 two-drum winder.

Paul Chessare, who has been associated with the parent company for over 15 years, has been appointed general manager of the newly formed company. Mr. Chessare most recently has served in the capacity of Divisional Sales Manager. Prior to that he had been senior service engineer.

In addition to Cameron equipment, Cameron do Brasil, will manufacture and distribute the complete line of the Clark-Aiken Co., including cutter-layboys, rollstands, and finishing room handling equipment.

Finland

A Second Paper Machine from Valmet Oy to Italy

Valmet Oy, Helsinki, Finland, has made an agreement with the Italian Co., Cartiere del Timavo S.p.A. for the building of a second high-speed newsprint machine for the company's mill in Trieste. Valmet Oy delivered the first newsprint machine to the same mill in 1958.

The paper machine is equipped with a differential drive,

a wire width of 229 mm., a constructional speed of 2450 m. per min., and an approximate annual production of 70,000 tons. It is characteristic of the type of newsprint machines being manufactured at Valmet Oy's Rautpohja Factory for the Finnish paper industry.

New Zealand

*Second Wallboard Mill For N.Z.F.P. Next Year**

Within a year N. Z. Forest Products, Ltd., expects to have a second wallboard mill in production at its Penrose plant. Construction of the building began recently and involves the demolition of the old casemill, and sawmill buildings. Estimated cost of the new mill is over £1,000,000.

The present "Pinex" mill, producing both insulating board and 8 × 4-ft. smooth-2-sides hardboard, has been running for 19 years and has reached a capacity of 80 tons per day. the new mill will start up with an output of an additional 40 tons expandable to 80 tons per day.

Maximum size sheet of hardboard possible will be 18 ft. × 4 ft. 6 in. allowing for much greater flexibility in meeting market demands and determining merchantable sizes.

Most of the machinery is being supplied by the Tayler Corp., of New Jersey, although much of the design and engineering rests with N. Z. Forest Products, whose experience in this field is well up to world standards. They will design and specify the preheater, among other components, while the main drier is to be part-constructed in N. Z. to American drawings.

An innovation in the industry will be the double drum board forming unit made by Ahlstrom, of Finland, as opposed to the existing one-drum unit now in operation at Penrose. The two drums will rotate in opposite directions, the pulp will be picked up on the surface of both, then pressed together and led over one of the drums. It is believed that considerable production advantages are held by this system. A. Kivi, the wallboard mill manager, has left for Finland to study the process before it is introduced here.

Bauer pulpers for the new plant have been ordered from the United States Wallboard Machinery Co., while Ahlstrom supplying the wet saw, automatic insulating board trim saws, and automatic hardboard trim saws in addition to the board forming unit. The mat handling system will be by the Wallboard Dryer Co. and the press by Siempelkamp.

Consideration was given by N. Z. Forest Products to introduction of the dry process for making hardboard following investigations overseas in 1958 by A. W. Mackney, Penrose production superintendent and chief chemist of the company, but a decision was finally made to continue with the existing system with some modifications.

The mill, of course, is the only one in N. Z. manufacturing building boards from wood fiber and is the genesis of the wide variety of "Pinex" wallboard products so familiar to the building industry.

---

* New Zealand *Timber Journal*, May, 1960

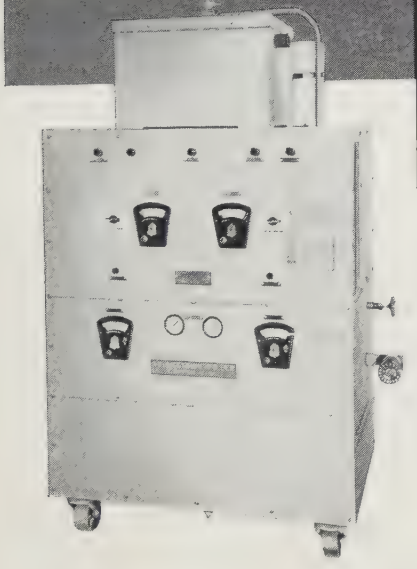
Pulp and Paper Manufacturers and Converters

Bulkley Dunton Pulp Co., Inc.

West Coast Office

A new sales and distribution office will be opening soon in San Francisco.

Robert M. Van Sant, appointed manager, will be responsible for the sale of fourdrinier wires manufactured by the United Wire Works of Edinburgh, Scotland, and also Horsehead titanium dioxide produced by the New Jersey Zinc Co.



Heat Transfer Systems

By YOUNGSTOWN MILLER

Ideal For

APPLICATOR PANS, MILLS, CALENDERS . . . ROLLS, COATERS, WAXERS . . . SUPPLY TANKS, ETC.

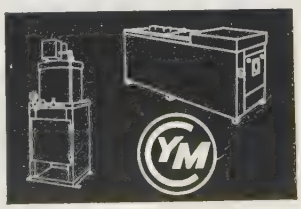
Indirect heat, exactly the way you want it—mild, uniform, fully controlled—economical and highly efficient. Truly units of many valuable features.

ENGINEERED TO YOUR NEEDS

- *High temperatures at low pressures—virtually no vapor pressure.*
- *Great uniformity of heat with close temperature controls (to one % of temperature range) up to 550 °F.*
- *Custom units designed to your special needs.*
- *Multiple temperatures from the same compact system, independently and closely controlled.*
- *Rapid cooling if desired—finned tube heat exchangers installed on specification—controlled manually or automatically.*

The highly versatile YM Heat Transfer Systems will handle the bulk of your process heating jobs to perfection—big or little—Production, Pilot and Laboratory installations alike. Here are units with efficient compactness which usually permits them to be incorporated in close proximity to the process requiring heat.

We have prepared comprehensive, workable engineering material and data for your particular use. Write or phone today for full information.



Also Mfrs. of Famous YM Oil Re-refiners and Plasticoaters

YOUNGSTOWN MILLER CORP.

190 WOODLAWN AVENUE
NORWALK, OHIO, U.S.A.

Brookshire C. Moore

Charles Ray

Continental Can Co.

Appointments at Augusta Mill

Continental Can has announced the appointments of Brookshire C. Moore to the position of paper mill superintendent, and of Charles Ray as pulp mill superintendent at the company's bleached sulfate paperboard mill, now under construction at Augusta, Ga.

Barthel Heads Bondware Research and Development

J. C. Barthel has been made general manager of the Research and Development Dept., Bondware Division, Continental Can Co. Announcement was made by Dr. Robert B. Mesrobian, general manager of the company's General Packaging Research and Development Division, of which Bondware R&D is a part.

J. C. Barthel

Mr. Barthel's experience includes 5 years as technical director of the paper chemicals department of American Cyanamid Co., where he coordinated work among the research and production departments with the technical field men and their paper manufacturer customers. Prior to this position and covering a total of 23 years with American Cyanamid, Mr. Barthel worked on new product development for the paper chemicals department, including 11 years in the paper chemicals research laboratory, where he worked on customer service problems and the development of paper sizes and coatings. He has a number of patents and technical papers in this area. His first work with Cyanamid was as a sales-service man to the paper mills in New England, New York, New Jersey, and Ontario.

Prior to the above, Mr. Barthel was employed at the Institute of Paper Chemistry for three years, in charge of pulp and paper testing. In 1933 and 1934, he was employed by the Sealright-Oswego Falls Corp. as a chemist.

R. R. Howarth, Columbia Box Board Mills, Inc.

A. J. Dimick, Columbia Box Board Mills, Inc.

Columbia Box Board Mills

Robert R. Howarth was elected president of Columbia Box Board Mills, Inc., Chatham, N. Y., at the board of directors meeting May 6. He succeeds his father, the late Charles W. Howarth, who died, March 26, 1960. In respect for Charles W. Howarth, the post of chairman of the board will remain vacant.

Arthur J. Dimick was elected to the post of executive vice-president and also a member of the board of directors.

Celgar, Ltd.

Appointments

Celgar has announced three appointments to key posts in its pulp mill operations. John E. B. Sawyer will be the plant engineer; Robert A. Robinson has joined the company as operating superintendent; and Norman A. Scott is industrial relations superintendent.

Crown Zellerbach Corp.

New Packaging Plant

A new plant is to be constructed at Hazelwood near the St. Louis airport, it was announced by D. J. Benjamin, vice-president for packaging. The plant will be located on a 27-acre site, with an additional 18 acres under option for possible future expansion.

As a production outlet of the company's Western-Waxide division, the new 245,000-sq. ft. facility will be the company's largest flexible packaging plant when completed by mid-1961. When in full operation, it will employ 450 persons.

Hammermill Paper Co.

Appointments

The election of John H. DeVitt as executive vice-president, John E. Franzen as vice-president, marketing, and Donald S. Leslie, Jr., as treasurer, has been announced by President Donald S. Leslie, Sr., following the annual meeting of Hammermill stockholders.

International Paper Co.

Appointments

The board of directors of IPC has elected Wallace K. Graves, George H. Rand, and John L. Tower as vice-presidents.

The board also appointed Edward Z. King, Jr., who has been an assistant treasurer, to the new corporate office of comptroller, and John S. Maxwell an assistant treasurer.

Donald B. Pooley has been appointed West Coast manager for IPC's corrugated shipping container and multiwall bag sales.

Kimberly-Clark Corp.

Expansion

K.-C. has announced the start of an expansion program that may make its Niagara, Wis., mill the world's largest producer of coated publication and catalog papers under one roof.

The program will include the installation of a new coated printing paper machine and the construction of additional mill facilities adjoining the existing plant. Construction will get under way immediately with startup of the new machine scheduled for Jan. 1, 1962.

Paterson Parchment Paper Co.

Approved Mold-Inhibiting Food Wrapper

A food packaging material capable of retarding food spoilage and extending food shelf-life has been introduced by Paterson Parchment of Bristol, Pa.

Called Patapar Vegetable Parchment 27-110T, the mold-inhibiting material is designed especially for packaging cheese, preserves, baked goods, processed meats and other products that have a tendency to form in storage. It is the first mold-inhibiting packaging material to be approved by the Food and Drug Administration as meeting the requirements of the 1958 amendment to the Federal Food, Drug, and Cosmetic Act. The parchment can be readily printed and easily glued.

Riegel Paper Corp.

Promotion

C. Cline Peters has been promoted to mill manager of the pulp and paper mill at Riegelwood, N. C. Mr. Peters replaces J. D. Dailey, who resigned.

Appointments

The Specialty Products Division of the corporation has announced the appointment of W. Allen Schenck to the newly created position of manager, New Jersey operations. He will report to G. Lamont Bidwell, vice-president and general manager of the division. Dr. Schenck will be responsible for all operations and services in the company's four N. J. mills at Warren Glen, Milford, Riegelsville, and Hughesville.

John H. Rich, formerly manager of converting and coating for the division, has been advanced to the newly created position of manager, special projects.

William Anderson will fill Mr. Steinbinder's former position of converting superintendent.

Scott Paper Co.

Promotions

Scott has announced the promotion of five members of its Chemical Research Division.

Edward A. Wodka has been promoted to the position of research group leader; Jerome M. Gess to research project leader; William P. Logan to assistant research engineer; and John R. Ryan to pilot plant operator.

St. Regis Paper Co.

Better Quality Board and Paper

Bleached board and paper of increased brightness and strength are being manufactured by St. Regis in its no. 1 mill at Pensacola, Fla., as the result of a chlorine dioxide system which went into operation late last month. The new process is the fourth stage in the kraft bleach plant which supplies pulp to two paper machines, one a fourdrinier and the other a cylinder machine.

The new bleaching sequence is: (1) chlorination, (2) first caustic extraction, (3) first hypochlorite, (4) chlorine dioxide, (5) second caustic extraction, and (6) second hypochlorite.

There were significant increases in strength, both in tensile and burst tests and brightness ranged up to 81 to 82.

Appointments

St. Regis announces the appointment of William E. Caldwell as senior vice-president of its Cornell Paperboard Products Co. Division and general manager of the Cornell operations at Milwaukee, Wis. He succeeds Arthur Miller, who will retire from this position on July 1. Mr. Caldwell is presently resident manager of the St. Regis mill at Pensacola, Fla.

T. Cecil Davis, presently assistant treasurer of St. Regis, has been named resident manager of the St. Regis mill at Pensacola, Fla., to succeed Mr. Caldwell.

Weyerhaeuser Co.

Research Branch in Seattle

A new branch office of Weyerhaeuser's research division will be opened June 1 in Seattle, Wash.

About 20 specialists grouped in two sections will be housed in the remodeled building located at 4123 Stoneway.

One section, headed by Dr. Fred Shafizedh, will engage in pioneering research, and the other will be concerned with research in the building materials field.

Educational Institutions

Syracuse University, College of Forestry

Solvay Awards Summer Fellowship

The State University College of Forestry at Syracuse University has announced that Solvay Process Division, Allied Chemical Corp., has awarded a summer (1960) research fellowship of $800 to the college. Named as the recipient is Miss Joan O. Brush of Sidney, N. Y., a senior majoring in chemistry at Harpur College at Endicott.

Paper Industry-Sponsored Scholarships

Nine pulp and paper technology majors at the College of Forestry have recently been presented scholarships sponsored by the pulp and paper industry.

Participating in the presentation ceremony held at the College of Forestry were Dr. Hardy L. Shirley, college dean, and Prof. Frederic W. O'Neil, chairman of the college's Department of Pulp and Paper Technology.

Lowell Technological Institute

Eleven B.S. degrees in paper engineering were granted at the 62nd commencement exercises of Lowell Technological Institute, June 5, among a class of 132 B.S. and 11 M.S. graduates.

Of the eleven, Roger D. Bartlett and Gerald P. Kennedy. will go to Beloit Iron Works in Beloit, Wis.; Leo J. Keenan to Texon in Hadley Falls; and Frank R. Zichelle to the University of Maine graduate school.

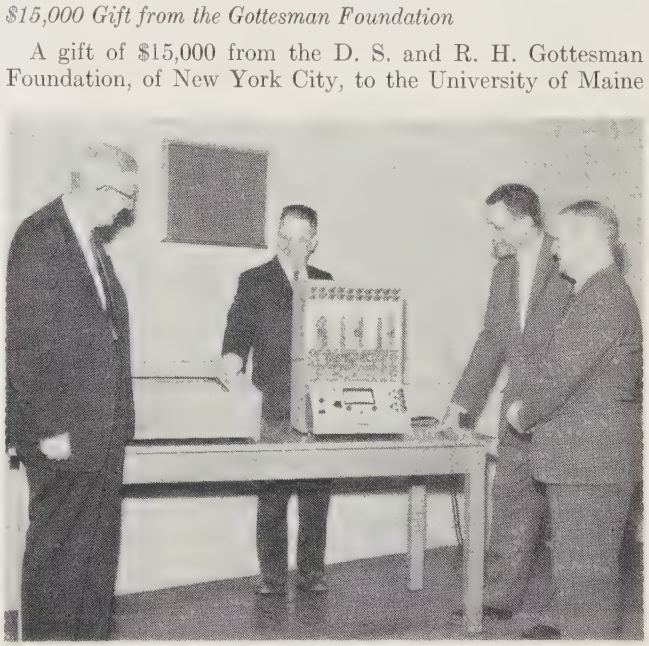
John Hickson is with E. D. Jones Co. in Pittsfield; Franklin R. Farrow with DeJong Co. in Fitchburg; and Howard A. Ayer is at Franklin Technical Institute in Boston.

Not registered with the placement offlce are Salvatore A. Benedetto, George L. Cunha, Kenneth E. Dolfe, Jr., and Edward C. Kiluk.

University of Maine

$15,000 Gift from the Gottesman Foundation

A gift of $15,000 from the D. S. and R. H. Gottesman Foundation, of New York City, to the University of Maine



Ira D. Wallach New York City president of the D. S. and R. H. Gottesman Foundation, is shown with the new equipment in the computation and analysis laboratory. Left to right: Charles E. Crossland, the university's vice-president for administration; Dean Weston S. Evans of the College of Technology; Mr. Wallach; and Prof. Lyle C. Jenness, head of the department of chemical engineering

has led to the establishment at the university of a computation and problem analysis laboratory named in honor of the late D. Samuel Gottesman, a pioneer in the pulp and paper industry.

The new laboratory, which is located in Aubert Hall, is furnished with calculator and analog computer equipment which will be used primarily in connection with the pulp and paper and chemical engineering activities at the university in the areas of instruction, research, and service. Among the many research uses cited were the solving of problems in the fields of pulp stock flow, drying of paper, and the drainage characteristics of pulp.

N. C. State College

N. C. State College formally dedicated and named its new Brandon P. Hodges Wood Products Laboratory on Wednesday, May 25, in ceremonies attended by members of the Hodges family and wood industry and forestry leaders from throughout the Southeast.

Long a friend of the State College, the late Brandon P. Hodges was a key figure in the development of several college facilities and programs, particularly in the fields of forestry, wood products, and pulp and paper technology.

Hodges, who died in 1958, was a former Buncombe County Attorney, State Senator, chairman of the Advisory Budget Commission, State Treasurer, counselor for the Champion Paper and Fiber Co., and secretary-treasurer of the Governor's Research Triangle Committee.

The new wood products laboratory is the only research facility of its kind in the Southeast and is regarded as one of the outstanding laboratories of its type in the region.

Industry Suppliers

Albany Felt Co.

New Giant Drier

A giant quarter-million-dollar drier is now in operation at Albany Felt Co.'s Albany, N. Y., plant. Designed and erected by Albany Felt plant engineering department personnel, the new drier provides more even nap and singe, and more thorough vacuuming, especially on wide felts.

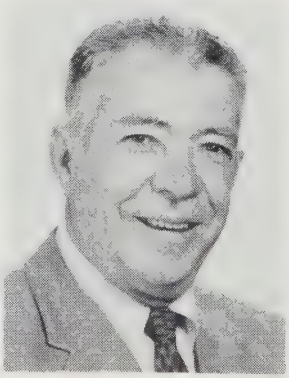
The drier has speeded up processing in the dry finishing operation, and its cantilever construction permits unobstructed loading and unloading of felts.

Drying is accomplished through the use of steam heated rolls and infrared lights and the machine utilizes 8 huge rolls each weighing 6000 lb.

Appleton Woolen Mills

Appointments

Appleton has appointed F. H. Singletary southern sales representative, effective May 1. His territory covers six states, including Mississippi, Arkansas, Texas, Louisiana and parts of Alabama and Tennessee.

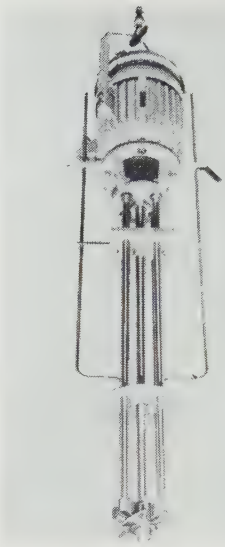


F. H. Singletary

Barrington Industries, Inc.

High-Shear Homogenizing Mixer

A complete line of highly versatile mixers for the laboratory and for production is now available under the name of Barrington convertible jet mixer, from Barrington Industries, Inc., 185 Union Ave., Providence, R. I. The models range from 1/4 to 15 hp., and in mixing capacities, from 3 to 3000 gal. Each model may be converted, in seconds, from closed turbine to open turbine mixer, or vice versa, providing a dual application mixer in a single unit.



The mixers blend, disperse, and homogenize materials of any viscosity which can be pumped or forced through the mixing head of the mixer. Shaft speeds range from 8000 r.p.m. for the laboratory models to 3600 r.p.m. for the production units.

The mixers are designed to draw the material being processed from below and to force it upward through the restricted jet openings of the mixing head without forming a vortex and without incorporating air in the material.

The Black-Clawson Co.

O. W. Hein Celebrates 40 Years with B.-C.

Otto W. Hein, vice-president of B.-C., has completed 40 years' service with the company. His major contribution to the growth of the company was expressed publically by Carl C. Landegger, administrative vice-president, at a recent ceremony in Middletown, Ohio, during which Mr. Hein was presented with a 40-year loyalty pin.

During 1959 Mr. Hein was advanced from general manager of the Paper Machine Division in Watertown, N. Y., to B.-C.'s corporate staff and was charged with the coordination of all production facilities and capital investments throughout the company. He has served Black-Clawson in many executive capcities. At various times he has been director of research and development, a general manager of the Shartle Division, and production manager of the Shartle Division.

Vice-president Otto W. Hein receives congratulations from Carl C. Landegger

The Borden Chemical Co.

Appointment

Edward F. Wezowicz has been appointed technical sales representative for the Polyco-Monomer Dept. of Borden.

He will be responsible for sale of the department's full line of synthetic resins in the New York City area. Mr. Wezowicz will make his headquarters at the Borden offices in New York City.

James H. Christopher, Jr., has been appointed sales manager for the Borden coatings and adhesives department. He will make his headquarters at the company's office in Peabody, Mass.

Columbia-Southern Chemical Corp.

Aid-to-Education Program

Industry, education, and government have combined in a concerted aid-to-education program to sponsor a $19,000 film series in chemistry marking the first time this new method of teaching chemistry will be used in any high school system in West Virginia, according to the Columbia-Southern.

Starting this fall, students in six high schools in Wetzel County will initiate a full years' course in chemistry on film as a result of the cooperative financial sponsorship. Columbia-Southern and the Wetzel County Board of Education will each share one-fourth of the cost and the remainder furnished by the Federal Government under the National Defense Education Act.

Corn Products Division

Industrial Proteins

The Corn Products Division, Corn Products Sales Co., 9 E. 55th St., New York 22, N. Y., is offering a new 40-page booklet entitled "Argo Brand Zeins G-200 & G-210—Two Versatile Industrial Proteins." Properties, solubility and compatibility, formulas and preparation methods are thoroughly discussed and illustrated with charts, tables, and curves. Present and projected uses for Zein corn proteins for pharmaceutical, food, and paper coatings, paints, inks, varnishes, cork seals, floor finishes, fusion resins, and release coatings are described in detail. Film forming, binding, and adhesive characteristics are also discussed.

Deloro Stellite Div. of Deloro Smelting & Refining Co., Ltd.

Cyclone Cleaner Cones

Deloro cyclone cleaner cones made from an especially developed cobalt, tungsten, chrome alloy, resist wear caused by the abrasive cyclone action of cleaners, as well as the corrosion of organic pulp acids, to last indefinitely.

Deloro Stellite, producers of cobalt and nickel base alloys since 1916, have in cooperation with the Canadian pulp and paper industry, perfected these cones for replacements on Bauer 600, 606, and 620 series cleaners. For additional information write to the company at Belleville, Ont.

Dorr-Oliver, Inc.

New Sales Division

Dorr-Oliver, Stamford, Conn., has set up a new Pulp and Paper Sales Division within its industrial sales area. This functional grouping corresponds to similar working units within the research, development, and engineering departments. Under the direction of Gordon M. Girdwood, the new sales division will be responsible for equipment and process sales to Dorr-Oliver customers in the expanding pulp and paper industry.

In addition to Mr. Girdwood, the new Pulp and Paper Division comprises I. W. Johnston, assistant division manager, who will serve the southeastern portion of the country from the D-O Atlanta office at 900 Peach Tree St., N. E.; R. E. Bodette, who will serve the northeastern portion of the country from the D-O Stamford office; T. B. Calhoun, who will serve the gulf coast states from the D-O Fairhope, Ala., office; R. M. Schneble, who will serve the North Central area from Roselle, Ill.; W. F. Wangler, who will serve the Mid-West from Fort Wayne, Ind.; Walter Christiani, who will serve the Western section of the country from the D-O Oakland, Calif., office at 2900 Glascock St.; and F. L. Schorken, sales specialist, and R. J. Spangenberg, staff assistant, both of whom will make their headquarters at the Stamford office.

Dyestuff and Chemical Div., General Aniline & Film Corp.

Paper Research Activities Expanded

The Division announces a major expansion in paper application research activities, and relocation of two of the company's paper specialists in connection with this new program.

Maurice J. Landberge and Bruce G. Webster will transfer from the company's Rensselaer, N. Y., plant to the firm's Central Research Laboratories at Easton, Pa., where they will establish this new function.

Mr. Landberge will contunue to be available as a technical representative to visit paper mills. Customer service will be performed at the Rennsselaer dye laboratory, as in the past.

The Flintkote Co.

New Container Plant in Mississippi

Flintkote, a major producer of corrugated containers and building products, announced plans for a new multimillion dollar corrugated container plant to be built at Magnolia, Miss.

The plant, to be located on a 15-acre tract on the outskirts of the City of Magnolia, in Pike County, in the southern part of the state, will be outfitted by Flintkote with over $1 million worth of machinery and equipment. The single-floor plant will occupy about 115,000 sq. ft., and is designed to provide for future expansion when necessary. At full capacity, it will employ 150 to 200 persons.

Great Lakes Carbon Corp.

Diatomite in Paper and Pulp Mills

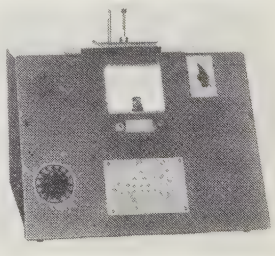
A technical bulletin describing the uses of diatomite in paper and pulp mills is available from the Dicalite Department of Great Lakes Carbon Corp. It includes details of diatomite application in groundwood pulp papers, sulfite pulp papers, soda pulp papers, kraft or sulfate papers, boards, roofing felt, molded paper products, and asbestos sheets.

Copies of bulletin No. F53 are available, without charge, from the Dicalite Dept. of Great Lakes Carbon Corp., 612 S. Flower St., Los Angeles 17, Calif.

Hunter Associates Laboratory, Inc.

Distinctness-of-Image Glossmeter

The Hunterlab D36 distinctness-of-image glossmeter is a photoelectric instrument that measures the capacity of surfaces to reflect images. It is applicable to paints, plastics, paper, ceramics and metal.



This instrument differs from conventional glossmeters by using a revolving slotted disk in place of the usual stationary receptor window. For additional information, write to the Hunter Associates Laboratory, 5421 Brier Ridge Rd., McLean, Va.

Improved Machinery, Inc.

Agitation and Storage Systems

Improved Machinery has published a new catlog on "Agitation." The catalog contains extensive information on all types of pulp agitation and storage systems.

Copies may be obtained by writing to Improved Machinery, Inc., Nashua, N. H.

The M. W. Kellogg Co.

Lance Crosby to Pulp and Paper Division

H. Lance Crosby's appointment as contract sales representative in the Pulp and Paper Division of M. W. Kellogg was recently announced by the company, a New York engineering and construction firm.

He is a member of the Pulp Purification Committee of TAPPI, and acts as liaison with the TAPPI Corrosion Committee. He is also a member of the A.I.Ch.E. and the ACS.

H. Lance Crosby

Samuel M. Langston Co.

Northeast Location for Sales Engineer

Langston announces the new location of sales engineer Alvin C. McCully at South Shaftsbury, Vt., a suburb of Bennington. He will have major responsibility for all of New England, eastern Canada, and most of New York State.

Chas T. Main, Inc.

Appointment

James M. Forrester has recently joined the pulp and paper group of Chas. R. Main, Inc., Engineers. Prior to becoming associated with Chas. T. Main in April, 1960. Mr. Forrester was a project engineer at Rust Engineering in Pittsburgh, and before that he was associated with H. K. Ferguson. Prior to that he was with Proctor & Redfern, and in the control engineering group of The Ontario Paper Co.

Modern Machines Co.

Promotion

Kay Leonard has been promoted to the position of development engineer. He has been serving as technician in the Morden laboratory and will now be concerned with the development of new products and the refinement of existing machines.

Morningstar-Paisley, Inc.

New Tapioca Flour for Corrugating

A new tapioca flour is described in a product information report recently published by Morningstar-Paisley. Of interest to those in the corrugating industry, the product, No. 61 Thai Crown tapioca flour, has excellent toleration to caustic and borax and offers a high initial viscosity and viscosity retention. The report includes formulas for using the product in a single- and dual-starch system, double backer, and dual-starch system, single facer, all for a 666-gal. mix. The report can be obtained without cost from Morningstar-Paisley, Inc., 630 W. 51st St., New York 19, N. Y.

Nalco Chemical Co.

Sodium Aluminate

Industrial uses of sodium aluminate, which rose to prominence as a water-treatment chemical, are described in a 12-page brochure available from Nalco. Entitled "Sodium Aluminates," the brochure outlines how the chemical can be used in such industries as chemical processing, cement and mortar, detergent, glass and ceramic, paint and pigment, pharmaceutical, pulp and paper, rubber and textile.

Copies of Bulletin K4 are available from the Advertising Department, Nalco Chemical Co., 6216 W. 66th Place, Chicago 38, Ill.

Nopco Chemical Co.

Charles P. Gulick Scholarship to Barbara Grant

George G. Stier, president of Nopco Chemical Co., has announced the selection of Miss Barbara Louise Grant as winner of the Charles P. Gulick Scholarship for 1960. Miss Grant is the daughter of David M. Grant, maintenance foreman at the Carlstadt (N. J.) plant of Jacques Wolf & Co., a Nopco subsidiary.

Established in 1956, the Gulick Scholarship is a tribute to the memory of Nopco's founder, Charles P. Gulick, who died in 1955, and to his interest in the education of America's youth.

Solvay Process Division Allied Chemical Corp.

Hydrogen Peroxide Bibliographies

Solvay has compiled five bibliographies on hydrogen peroxide, which it has now issued as separate booklets under the following titles:

- Literature Review of Hydrogen Peroxide in the Preparation of Organic Peroxides
- Literature Review of Analysis, Spectral Characteristics and Physical Properties of Hydrogen Peroxide and Organic Peroxides
- Literature Review of New Developments in Epoxidation and Hydroxylation of Unsaturated Compounds
- Literature Review of Hydrogen Peroxide and Organic Peracids as Oxidizing Agents
- Literature Review of the Mechanism of Decomposition and the Reactions of Hydrogen Peroxide and the Organic Peroxides

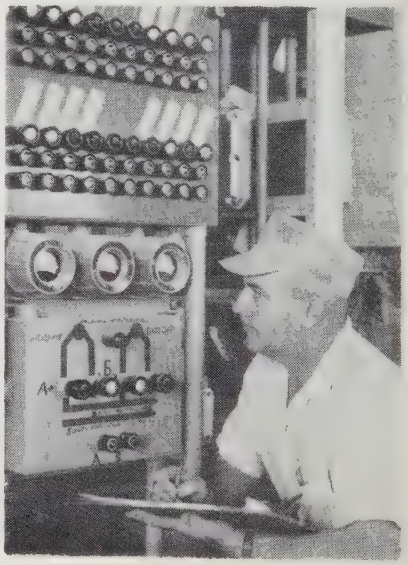
These booklets represent an attempt to compile the most generally applicable literature references available on the subjects described in the above titles. Each booklet contains introductory material covering the subject in broad terms.

A. E. Staley Mfg. Co.

Giant Dextrin Blender

The world's largest dextrin blender and a patented dextrinization process are producing carloads of uniform and specification-sure dextrins at Staley.

The blender, 18 ft. long and 17 ft. wide, has a single batch mixing capacity of up to 80,000 lb. Its huge size and thoroughness of blending does away with an old industry problem of maintaining blend uniformity when more than one batch was used to make up a shipment.



Operator Frank Dorsey checks control panel on giant, 80,000-lb. capacity dextrin blender

Teamed with Staley's patented fluidizer conversion process, the big unit assures peak uniformity in maintaining exact customer specifications on dextrins. The fluidizer process fluidizes starch by air flow during conversion, providing extremely even distribution of heat and chemical to each particle to eliminate scorching common in conventional converters.

Appointment

Donald A. Dempsey has been appointed paper technical sales representative of A. E. Staley in southestern states.

Mr. Dempsey succeeds William C. Gallagher, who was recently named southern regional manager in the Staley sales and technical service organization, serving the paper and related industries.

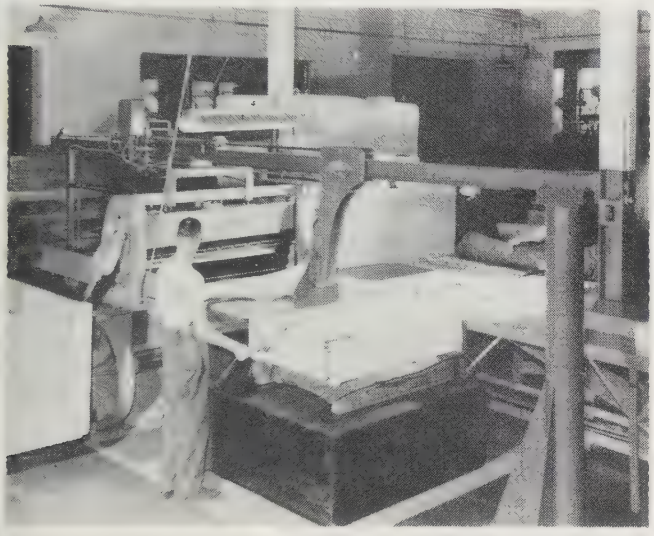
Donald A. Dempsey

Chas. R. Stevens, Inc.

Automatic Unstacker and Trimmer Loader

Trimmer production can be increased from 30 to 40% a day by one trimmer operator using a new automatic unstacker and trimmer loader developed by Stevens, Maumee, Ohio.

At the push of a button, the machine automatically separates and unstacks a trimmer lift from the skid and delivers it, with a single continuous stroke, to the trimmer table, ready to cut. The lift is floated off the skid without drag, peel, or damage to the paper.



Automatic unstacker and trimmer loader

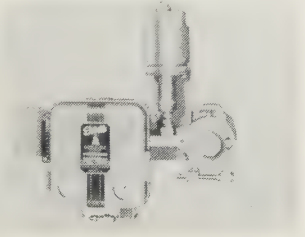
One operator working continuously and productively without costly waste, lost time, or fatigue, can cut more paper than 2 men using the conventional manual method of trimmer loading, thus effecting an important saving of direct labor plus higher daily production.

For additional information contact Charles R. Stevens, Inc., 501 W. Sophia St., Maumee, Ohio.

Stickle Steam Specialties Co.

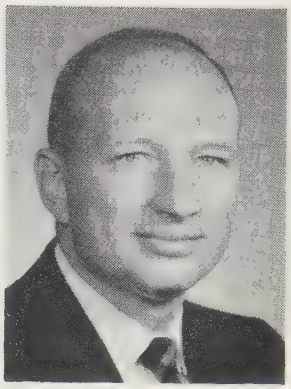
Improved Moisture-Control Detector

More accurate moisture control is promised by a new detector with adjustable sensitivity for any weight of paper from 0.0003 to the heaviest board. The model 300-F moisture detector is offered by Stickle Steam Specialties Co., 2215 Valley Ave., Indianapolis 18, Ind. It is designed for use with any Stickle Pres-Ten-Trol system to control moisture content automatically during paper drying.



A numbered dial on the detector permits quick setting of any desired sensitivity, while a proportional band prevents overregulation. On machines running a wide range of basis weights, the best setting for each weight is quickly obtained. An identical setting may be accurately duplicated whenever the same weight is run again.

Harold S. Atwood, Virginia Smelting Co.



Robert W. Barton, Virginia Smelting Co.

Testing Machines, Inc.

G.E. Column Crush Test

TMI announces the G.E. column crush test, a device for measuring the resistance of corrugated and solid fiberboard to edgewise compression, to predict the probable crushing resistance of the finished containers to crushing forces as they are subjected under warehouse stacking conditions.

For complete details write to Testing Machines, Inc., 72 Jericho Turnpike, Mineola, N. Y.

Virginia Smelting Co.

Promotions

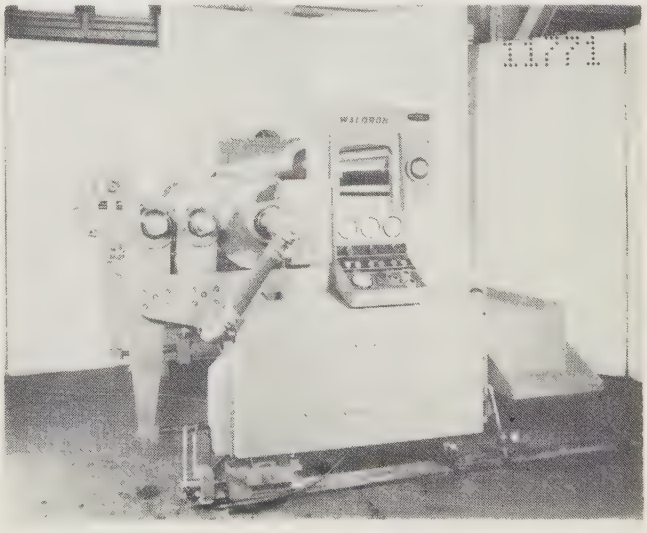
Dr. M. A. Kise, director of research for the company, recently announced the promotion of Harold S. Atwood to manager and Robert W. Barton to supervisor of the technical service department.

Waldron-Hartig Division Midland Ross Corp.

Extrusion Coaters Have New Features

The new model extrusion coating-laminating machine equipment provides many new features which give improved operation characteristics and provide maximum versatility. The coater is mounted on track rails for movement away from the extruder, thus eliminating the necessity for movement of the extruder.

In addition, the entire coater assembly may be raised and lowered by push button controls; the distance between the die jaws and the laminating nip can be adjusted while



The new model extrusion coater

running; and other adjustments include web alignment controls and positioning of the roll nip in the horizontal plane with respect to the extruded film.

The coater design permits the use of interchangeably sized chill rolls, the 18 and 24 in. being the two standard sizes. Rubber or silicone coated pressure rolls from 6 to 10 in. can also be employed. A chrome-plated, water-cooled backing roll is provided to cool the rubber roll by surface contact. The same machine may be adapted to chill roll film casting by the addition of auxiliary rolls and drive modification.

General

American Standards Association

American Standard Methods for determining the dimensional change characteristics of photographic films and papers have been approved and published for the first time by the American Standards Association.

Designated PH1.32-1959, the new Standard sets down uniform methods and techniques for determining the dimensional change of photographic films and papers caused by (1) variations in moisture content owing to change in the relative humidity of the atmosphere (humidity coefficient of expansion); (2) change in temperature (thermal coefficient of expansion); (3) the normal processing steps of developing, fixing, washing, and drying; and (4) processing plus aging.

"American Standard Methods for Determining the Dimensional Change Characteristics of Photographic Films and Papers," PH1.32-1959, is available at $1.50 per copy from the ASA, Dept. PR 148, 10 East 40th St., New York 16, N. Y.

U. S. Forest Products Laboratory

Report No. 1698, "The U.S. Forest Products Laboratory," is an up-to-date account of the Laboratory's objectives and activities and one of nine new or revised reports recently issued by the Laboratory. Other reports available are:

Adhesives and Their Application to Fabrication of Farm Structures, No. 2178.

The amount of material lost because of inaccuracy in sawing and how to remedy such losses are explained in a new report, Volume Loss from Inacurate Saving, No. 2174.

Training Teen-Aged Trees, No. 2176 presents an illustrated account of the problems encountered in growing trees from seedlings to maturity and suggests some corrective measures.

The physiological characteristics of soft-rot fungi and isolation data on over 100 organisms are contained in a report, Wood-Attacking Capacities and Physiology of Soft-Rot Fungi, No. 2173.

Two progress reports: Comparison of Wood Preservatives in Mississippi Post Study, No. 1757, and Comparison of Wood Preservatives in Stake Tests, No. 1757, incorporate the latest research findings pertaining to wood preservatives and treatments used in these two studies.

Tips on sorting, piling, and protecting Engelmann spruce for kiln drying, along with carefully prepared kiln-drying schedules, are contained in the revised report, Kiln Drying of Engelmann Spruce, No. 1944-6 (Rev.).

Nonplastic Molded Pulp Products, No. 1964, revised to include recent information relating to raw materials, equipment, and methods of manufacture of molded pulp items, such as egg cartons, pie plates, florist vases, and toys.

Single copies of these reports are available free upon request from the Director, Forest Products Laboratory, Madison 5, Wis.

Forest History Society, Inc.

George T. Morgan, Jr., 28, graduate student and former teaching assistant in American History at the University of Oregon, was named today as research associate on the staff of the Forest History Society.

Announcement of the appointment was made by Elwood R. Maunder who directs the Canadian-American group's continent-wide search for and study of sources of forestry, conservation, and forest industry history.

Morgan joins the society's staff after completing an M.A. dissertation on the public career of the late Colonel William B. Greeley, former chief forester of the United States and one of the principal architects of North American forest policy.

Paper Mills Cut Pollution in Wisconsin Rivers*

According to reports submitted to the Advisory Committee on Waste Disposal of the Wisconsin pulp and paper industry, the Wisconsin, Chippewa, Flambeau, Fox, Menomineè, Oconto, and Peshtigo Rivers, tested for pollution at over 50 stations, showed improvement over 1958.

Bad spots still remain on the Wisconsin, except below Tomahawk, Wausau, and Stevens Point. On the Flambeau, the oxygen deficiency occurred intermittently, in 1959, from Highway 8 bridge to Crowley Dam. The Fox was deficient in oxygen from Kaukauna to Green Bay, the Peshtigo near Green Bay, and the Oconto from below Oconto Falls to the Oconto Bridge.

Wisconsin's turbine aeration program, first in the United States in trials at three dams in 1958, will be expanded again in 1960. Power plant turbines and mill grinders will force air into river waters at 10 locations on the Wisconsin River and five on the Fox River, in 1960.

Reports for 1959 indicated that the turbines at Rothschild did the top job in mixing air through the turbine blades to get more oxygen dissolved in the water. The aeration was spread over 69 days at Rothschild, adding an estimated 12,500 lb. of dissolved oxygen daily.

Other turbine aeration projects last year were operated at Wisconsin Rapids, Port Edwards, the Petenwell Dam, at Kimberley and at Combined Locks and Rapid Croche Dam on the Lower Fox.

High water volume in 1959 was credited for part of the better showing on the rivers used by the pulp and paper mills. For population controls, some 20 mills spend $1,150,000 in 1959 in addition to a total of $289,200 for research.

At 15 sulfite mills, there were eleven hauling spent liquor for use as road binder, three burning liquor concentrate, two making yeast, one salvaging chemicals and lignin and eight using lagoons or soil filtration to reduce river pollution.

Chlorine Dioxide Bleach Tower

A concentric tower design, introduced by Dorr-Oliver, Inc., Stamford, Conn., provides high density chlorine dioxide bleaching of kraft and other pulps with improved uniformity control, and efficiency. It employs upflow-downflow operation in a single, compact structure.

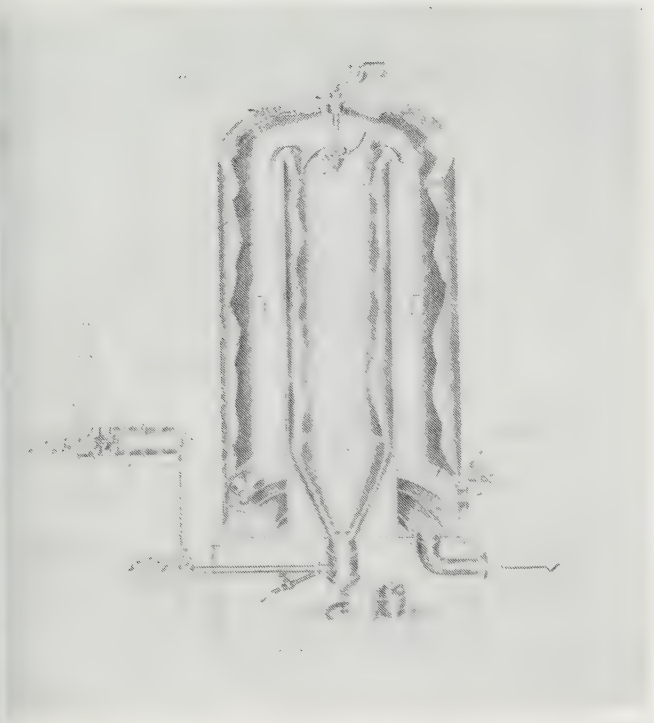
The bleaching tower unit (see sketch) consists of external heater-mixer, thick stock pump and ClO_2 mixer; and inner "upflow" tower with unique "plumb-bob" distributor; and an outer "downflow" cylinder including dilution, neutralizing, circulation, and discharge equipment. The concentric design is unusually compact, and eliminates the need for mounting equipment above the bleaching tower. The low diameter: height ratio limits surface area and, consequently, reduces heat loss.

Chlorine dioxide is introduced to the pulp at the base of the tower, which keeps the mixture under hydrostatic pressure for nearly an hour. By the time the pulp is distributed over the circular top weir, 90% of the ClO_2 is consumed, reducing ClO_2 losses and preventing puffs. The "plumb-bob" distributor spreads the pulp uniformly into the annular downflow section.

Retention time in the downflow phase can be varied to meet changes in pulp and tonnage requirements, and to provide continuous control of the reaction. Dilution, neutralization, and repulping are accomplished in the bottom zone of the annular downflow section. Retention time and other controlling factors in the treatment can be held constant for almost all the pulp through drawdown, in the event of shutdown or change of pulp grade.

The design is simple, dependable, and inexpensive, incorporating standard tile-lined steel construction. Leading

* Everett Swingle, *Milwaukee Sentinel*, April 13, 1960.



Chlorine dioxide bleach tower

tiling concerns estimate lower first costs and predict lower maintenance costs because of the small surface area and the absence of small diameters and compound curves in the reaction zone.

The new Dorr-Oliver bleaching tower offers the following advantages over previous designs:

1. ClO_2 losses reduced; puffs eliminated.
2. Retention time fully controlled; even during emptying.
3. Minimum space required; heat loss and power requirements minimized.
4. Reaction limited to tower proper; ClO_2 is introduced at charging port, neutralized before discharge.
5. First cost substatntially reduced.

The new tower is now successfully operating in kraft pulp production, and is available in 100 to 800-ton-per-day capacities. It is suitable for erection either indoors or out, and is fully compatible with normal flow sheets for kraft pulp production incorporating one or more chlorine dioxide bleaching stages.

Patent protection has been applied for.

Black Mica as Food Additive

According to a Chicago food specialist, vermiculite (black mica), a mineral mined for use as a soil conditioner and building material, is not only edible but might reduce the dangers of radioactive contamination in the human body.

Dr. Milton E. Parker, chairman of the food engineering department at IIT, outlined some of the prospects of vermiculite in an address, "Patterns in Nutrition," at the annual research meeting of the Food & Container Institute at the Congress Hotel.

Vermiculite is mined chiefly in Montana and South Carolina; it is a hydrated magnesium aluminum iron silicate and is widely used as a lightweight concrete and plaster aggregate.

As an additive in food products, e.g., cookies or bread, vermiculite could limit the recycling of such high fission yield products as cesium and rubidium and is effective in eliminating radioactive contaminants in foods, based on animal experimentation. In animals, it causes radioactive materials to be excreted through the intestinal system, rather than the urinary system, thus reducing the possibility of being absorbed by body tissues.

Vermiculite does not impair the assimilation of vitamins and also might contribute significantly in reducing calories for the control of obesity.

Glass Pillows and Balls

Corning Glass Works is mass producing tiny pillows and balls of glass as a low-cost material for filler, packing, filtering, and tumbling applications.

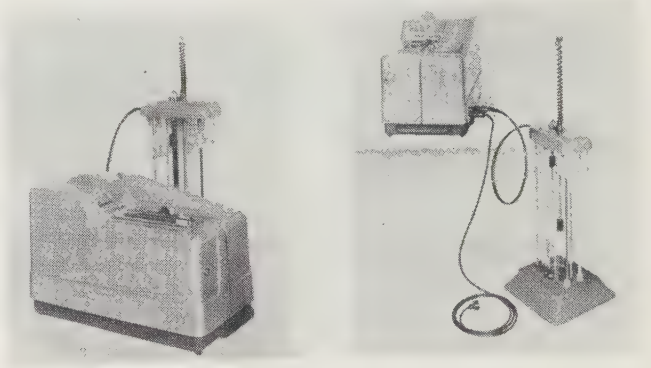
The hollow pillows provide a low density filler material for such applications as packing in aircraft wings where the glass gives both structural support and buoyancy. They also can be used as a filler material in the casting of larger plastic pieces.

The solid pillows are being used in chemical processing as fillers in fractionating colums and in filter beds. There tumbling action provides the necessary agitation in electroplating operations.

In commercial application, the ball-shaped pieces are used in the antilint filter of an automatic washing machine. The balls pick up the lint which is then back-flushed. This prevents clogging and stoppages.

Trace Impurities Detector

An automatic instrument that can detect as low as two particles of solid impurity in a billion parts of liquid has been developed by Graver Water Conditioning Co., New York. It can be used to monitor the quality of boiler feedwater and condensate in industrial power plants; to act as quality control for process water and manufactured products in regard to purity and proper ingredient content; to test the ultrapurity of rinse waters, jet and missile fuels, hydraulic fluids in servo systems, and the instrument potentially can be modified to sample plant atmosphere and gases as well as test for solubles and radioactivity.



The trace impurities detector. Left—Graver automatic tape analyzer with volume measuring tank in background. Right—Full view of analyzer showing external controls and hookups for inlet, outlet and power

Called the Graver Automatic Tape Analyzer, the analyzing method of the device is the Millipore Filter test. In this test particulate material is quantitatively removed from a liquid or gaseous sample by an ultrafine Millipore Filter membrane and retained on the surface where it may be easily identified, sized, counted, or tested.

For further information, contact: Martin Wank, Manager, Sales Promotion, Graver Water Conditioning Co., 216 West 14th St., New York 11, N. Y., WAtkins 4–2321.

Safety Talks for Foremen

The National Safety Council has published a new volume of "Five Minute Safety Talks for Foremen." The book—10th in a general industrial safety series—is divided into sections on motivation, machines and tools, materials, movement and managing men.

A collection of 52 safety talks written by Robert L. Moore, superintendent of engineers, Kemper Insurance Co., the book is based on material he gathered in more than 20 years in safety engineering.

Further information and quantity prices on Book 10 of the

"Five Minute Safety Talks for Foremen" may be obtained from the NSC, 425 N. Michigan Ave., Chicago 11, Ill.

Food-Paper Color Seminar

Food-Paper Color Seminar

Discussions aimed at providing food-paper colors acceptable to the 1958 Federal Food Additive Amendment were held recently in Buffalo, N. Y., by Allied Chemical's National Aniline Division representatives to the pulp and paper industry.

According to Jack F. Wright, product manager, paper dyes, the three-day seminar was devoted to overcoming the confusion existing since the enactment of the Food Additive Amendment. National Aniline has taken two avenues of investigation to continue to provide customers with colors which meet the requirements of present or pending laws.

Primary investigations are being undertaken in conjunction with co-members of the Synthetic Organic Chemical Manufacturers Association of the U. S. and are aimed at obtaining exemptions to the 1958 Food Additives Amendment for previously used dyes by providing nonmigration. Successful completion of this approach would provide the least disturbance with regard to food paper colors.

The second approach is to provide colors which will be acceptable to the Food and Drug Administration even though migration occurs. National Aniline is now developing techniques of applying such certified food colors to paper and plastic products.

While the enactment of a Color Additives Amendment this year may effect changes in the current situation, the present certified food colors are the only FDA-approved coal-tar dyes.

Soviet Technical Articles Reviewed

A weekly review of scientific and technical articles appearing in the Soviet press and of significant new Russian books is now being published by the Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce.

Called "Current Review of the Soviet Technical Press" (Order No. 60-21441), the publication is sold on subscription by OTS at $7 for six months ($2 additional for foreign mailing). The time lapse between appearance of an original article in a Russian publication and its review is no more than a few weeks and usually within a month, according to OTS.

PETRO AA as a Digester Additive

According to Petrochemicals Co., excellent and very profitable economic advantages are obtained through the use of PETRO AA as a digester additive. An unusual surface-active agent, it has outstanding hydrotropic properties and is soluble and stable in the cooking liquor. One of its functions is to activate the cooking liquor; getting the reactions off to a faster start; thus producing a milder cook resulting in a conservation of cellulose. The increased yield is produced from various wood blends, and on 100% pine it is even greater.

The following figures show the results of an extensive series of control cooks with and without PETRO AA. These cooks were run in alternate groups of about 500 cooks each to average out the operating variables. A solution of PETRO AA (5 lb./ton of pulp) was sprayed on the chips as they entered the digester.

	Control	*Using PETRO AA*
Total number of cooks	1,610	1,603
Tons airdry pulp produced	21,846	22,710
Tons airdry pulp per cook	13.57	14.18
Tons moisture-free wood used	37,705	37,679
Increased yield of pulp produced (tons)	..	864
Reduction in wood used (tons)	..	26

The 864 tons of pulp produced was actually obtained with less wood, and 7 less cooks. Cooking time was reduced 10% and this was all taken off at maximum temperature. A saving in steam and labor would result from the reduction in temperature, and reduction of number of cooks. About 3% less alkali is required in the PETRO AA cooks. The pine was cooked to a permanganate no. of 20, and the hard wood blends, to 14. The pulp is bleached, and meets all standards of high quality. The number of cooks made possible per day is increased by about 5.9% and the investment in PETRO AA is $1.45/ton airdry pulp produced.

Computer Opens New Techniques in Research

Complex research problems, previously considered too lengthy to consider, are now being solved by The Mead Corp. at its Central Research Laboratories in Chillicothe, Ohio, through use of a general purpose computer. Mead is a leading manufacturer of paper, paperboard, wood pulp, corrugated containers, folding boxes, packaging cartons, and special types of papers.

Approximately 45% of the work done by the computer, according to Dr. W. C. Rutledge, consists of one- or two-shot research and design problems, such as part of a paper machine or mass and flow balances. Statistical programs are one of the most valuable types run on the computer.

Owing to the variability of paper products and paper itself, hundreds of pieces of data must be analyzed at once. Parts of a paper machine can now be designed where previously the hosts of variables and relationships were too formidable to tackle. Use of the computer, a G-15 made by the Computer Division, The Bendix Corp., has raised the technical level of the work that can be done, and gives the solutions fast enough to be of value in making decisions. Twenty per cent of the computer's work is directly concerned with production, such as quality tests of paper; 30% is statistical, and 5% is data reduction.

A technical staff of 70 utilizes the computer. Of this number, 35 have been programming and running their own problems. Recently, however, a regular programmer-operator and an off-line Flexowriter operator have been employed to improve the computer services. The off-line Flexowriter enables the operator to punch data and program tapes which may be entered in the computer by the rapid photoelectric reader. This minimizes input time and leaves more time for actual computing. Output is often presented by the Bendix graph-plotter accessory in addition to the usual typed columns.

OBITUARY

Francis J. Curtis

Francis J. Curtis, former vice-president for personnel of Monsanto Chemical Co., died of a heart ailment at Barnes Hospital, St. Louis, Mo., on April 21, 1960.

Mr. Curtis retired last year after 44 years of service with Monsanto and the Merrimac Chemical Co. He was born in Cambridge, Mass., on April 24, 1894, and graduated from Harvard University in 1915. Following graduation he became a department superintendent for the Merrimac Chemical Co. in North Wilmington, Mass., in charge of salt cake, muriatic acid, and glaubers salt manufacture.

Mr. Curtis was transferred to St. Louis in 1935 where in 1939 he became vice-president of the Monsanto Chemical Co. He was a past president of the American Institute of Chemical Engineers and the Society of Chemical Industry. He became a member of the Technical Association of the Pulp and Paper Industry in 1926.

ENGINEERING DIVISION

Engineering Data Program

The Engineering Division of TAPPI invites you to join our Engineering Data Program. The purpose is to increase the division services to the members and to the industry.

We all have engineering data in everyday use, or in our files, that would make excellent TAPPI Data Sheets. You have no doubt solved many mill operations and maintenance problems, the solution of which, if properly presented, would be of real service to the mill engineer.

We recognize that you are very busy and can not find time to put these data and solutions to problems in the form that they could be readily published. This is where our Data Sheet Committee and TAPPI Staff can really function in making this information available. Please send in your rough draft. We will do the rest.

The officers of the Engineering Division urge that you keep this request in mind and please let us have your assistance and co-operation. You will be doing the industry a real service.

Thanks ever so much.

M. J. Osborne, *Chairman Engineering Division*

Questions and Answers

Good engineering questions are solicited as well as answers or alternate answers to the published questions. Material should be sent to TAPPI Headquarters, marked for the attention of H. O. Teeple. The items contributed will be forwarded to the Question and Answer Committee for processing. If comments are to be contributed, please refer to the question number.

(1-7/60) *Question:* **What is the average life of the overlay in digester cycles or years? The end point to be determined when the overlay is worn through in small areas and the original steel in these areas is being attacked.**

(*1.1-7/60*) *Answer:* There is no average life figure available. Overlay life has ranged from 18 months to 10 years.

(2-7/60) *Question:* **Is it possible and practical to apply a thicker overlay in patches or bands around the digester where excessive wear is known to occur?**

(*2.1-7/60*) *Answer:* Yes, heavier overlay can be applied where desired. This has been done in some cases, using two layers of overlay. Two layers appear to give better corrosion resistance than a single layer.

(3-7/60) *Question:* **What is an average figure for the relative cost of overlaying versus digester replacement?**

(*3.1-7/60*) *Answer:* The cost of overlay has ranged from $20 to $35 per sq. ft. depending on the area covered and procedure used. The cost of overlaying a 1300 sq. ft. digester surface at $25 per sq. ft. would amount of $32,500. Costs of installation of replacement digesters have been quoted as ranging from $40,000 to $200,000. In the latter case, a middle of the line digester would have had to be cut and removed in pieces, all the preceding digesters moved successively, and the replacement digester installed at the end of the line.

(4-7/60) *Question:* **Can a second overlay readily be applied over an overlay which has worn through in places?**

(*4.1-7/60*) *Answer:* Yes, see (10-5/60) (May, 1960).

(5-7/60) *Question:* **What is the best type of stainless steel to apply to kraft digesters?**

Rudolph T. Greep
S. D. Warren Co.,
Cumberland Mills, Me.

(*5.1-7/60*) *Answer:* The best type of stainless steel to apply in kraft digesters has not been determined. It is under study. There is some thought that for automatic overlay, a wire with 28% min. chromium, 20% min. nickel, and 2.75% min. molybdenum should be employed. Excellent results have been obtained with manual arc overlay using a lime coated type 310 stainless rod, preferably with 0.50% molybdenum. The technique exmployed is important, no matter what rod or wire is used.

(6-7/60) *Question:* **What is the current status of inert gas shielded welding vs. flux submerged welding in continuous machine overlay? What is relative success?**

(*6.1-7/60*) *Answer:* Both inert gas shielded and submerged flux shielded automatic overlays have been installed. There have been failures as well as satisfactory results with both methods. There are advantages and disadvantages in the use of either process.

(7-7/60) *Question:* **What problems are encountered at boundaries of stainless steel overlay where only partial overlay jobs are done?**

A. A. Bernhardt
Nekoosa-Edwards Paper Co.,
Port Edwards, Wis.

(*7.1-7/60*) *Answer:* In most instances where partial overlay has been installed, there have been no problems at the stainless boundaries. In some cases where the perimeter has not been enclosed and feathered out with fine beads, some undercutting of the carbon steel has occurred. If there are areas subject to rapid attack and the stainless overlay does not extend beyond the attack zone, the unprotected carbon steel may be corroded-eroded rapidly.

(8-7/60) *Question:* **Has anyone had experience with American-Marietta's Valdura Epory "Val-Chem Epo-Surfacer?" It is primarily a floor resurfacing and hardening material, but we have heard it was used to resurface the cone of a digester.**

(*8.1-7/60*) *Answer:* The panel has no information regarding the resurfacing of the cone of a digester with an epoxy resin coating.

Note 1: Questions and answers marked with asterisk (*) are reproduced courtesy *Power* magazine.

Note 2: Questions or answers preceded by the letter (R) indicate that the material has been previously submitted by the Chairman of the Question and Answer Committee.

(9-7/60) *Question:* **What is the latest experience on overlay welding? Are the operators able to overlay without having cracks and porosity develop after a year or two of service?**

(*9.1-7/60*) *Answer:* There has been cracking in some recent overlay applications. It is hoped that with improved technique, careful control, and new stainless wire chemistry, that cracking can be prevented.

(10-7/60) *Question:* **What is the cost difference, if any, between overlay welding and plug welded stainless plate lining? Which method could expect better service life?**

W. C. James
Crown Zellerbach Corp.,
St. Helens, Ore.

(*10.1-7/60*) *Answer:* Our best information would indicate that stainless overlay is slightly less expensive than a plug welded stainless lining. The experiences with plug welded linings has generally been unsatisfactory. Stress corrosion cracking at the plug welds has caused rapid failure of the lining.

(11-7/60) *Question:* **Are all failures of stainless overlay from the outside surface in or does the corrosion sometimes move through a holiday and work from behind which could lead to a sudden known failure?**

(*11.1-7/60*) *Answer:* We know of no sudden failures caused by leakage of liquor through stainless steel overlay.

(12-7/60) *Question:* **Are stainless overlay failures similar to the failures of our steel shells in that we can calculate the rate of corrosion and thus establish a date of failure? Or is it a sudden thing?**

(*12.1-7/60*) *Answer:* It would be difficult to calculate the date of failure of stainless overlays. The failures which have developed are not due to a general attack all over the surface but to cracking and deep grooving. In many instances, the failed areas constitute only a small portion of the entire overlay surface.

(13-7/60) *Question:* **How close do most companies allow a digester to appraoch the minimum thickness before beginning overlay?**

(*13.1-7/60*) *Answer:* There is no definite practice on how close a digester shell should be the minimum thickness before starting overlay. It would be preferable to leave a $^1/_4$ in. leeway above the minimum thickness.

(14-7/60) *Question:* **Has anyone gone to stainless steel blow lines and liquor lines?**

(*14.1-7/60*) *Answer:* Some stainless steel blow lines and liquor lines have been installed.

(15-7/60) *Question:* **Are new digesters being built of an alloy steel to resist corrosion?**

C. L. Peterson
The Mead Corp.,
Kingsport Div.,
Kingsport, Tenn.

(*15.1-7/60*) *Answer:* A number of digesters have been built using stainless or Inconel clad carbon steel plate. Some digesters have been constructed of solid stainless steel.

(16-7/60) *Question:* **Do you feel that center screens, placed with the back of the screens within $^1/_2$ to $^3/_4$ in. of the digester wall could prevent circulation of liquor at this point and cause a concentration of heavy liquor which could cause accelerated corrosion at this point?**

(*16.1-7*) *Answer:* In some digesters with center screens, there has been attack behind and also below the screens.

(17-7/60) *Question:* **What does the committee feel is the *best* material for use as a grout and mortar for installing carbon brick?**

Robert A. Levine
Champion Paper & Fibre Co.
Carolina Div.,
Canton, N. C.

(*17.1-7/60*) *Answer:* The question of the *best* material for use as a grout and mortar for installing carbon brick will be referred to Messrs. Beaumont Thomas of Stebbin Engineering and Manufacturing Co., Watertown, N. Y., and Alan O. Caldwell of Service and Erection Co., Pittsburgh, Pa.

(18-7/60) *Question* (**Volts Drop in Power Line**): **If 250,000 circ. mil. conductors were used to transmit 800 hp., having a power factor of 0.80, 8000 ft., at 2200 v., on a three-phase 60-cycle system, with the conductors spaced in a triangle 24 in. apart, what would be the volts drop in the line?**

(*18.1-7/60*) *Answer:* The volts drop in a three-phase circuit may be calculated in the same way as for a single-phase circuit transmitting one half the load. Therefore, in this problem, find one half the three-phase load in amperes and proceed as if calculating a single-phase circuit. Half the single-phase watts W = hp. $\times$ 746 $\div$ 2 = 800 $\times$ 746 $\div$ 2 = 298,400 and current I,

$$I = \frac{W}{E \times PF} = \frac{298{,}400}{2200 \times 0.80} = 170 \text{ amp.}$$

The volts drop in the circuit is made up of two parts, one the resistance component and another the reactance component. If E_R represents the volts drop due to the resistance of the conductors and E_x the volts drop due to the reactance of the circuit, we have $E_R = 2LIR/1000$, where L equals length of conductors in feet one way and R the resistance per 1000 ft. of conductor; and $E_x = 2LIX/1000$, where X equals the reactance drop in volts per ampere per 1000 ft. of conductor at 60 cycles, conductors spaced 24 in. apart; as obtained from a table $X = 0.110$. Then

$$E_R = \frac{2 \times 8000 \times 170 \times 0.042}{1000} = 114.24 \text{ v.}$$

and

$$E_x = \frac{2 \times 8000 \times 170 \times 0.110}{1000} = 299.2 \text{ v.}$$

The volts drop in the line is

$$E_d = \sqrt{E_R^2 + E_x^2} = \sqrt{114.24^2 + 299.2^2} = 320.3 \text{ v.}$$

This is equivalent to 320.3/2200 = 14.55% drop, considerably higher than would be considered good practice.

ECONOMIC ASPECTS OF PRESSURES AND TEMPERATURES FOR PULP AND PAPER MILL POWER PLANTS

14th Engineering Conference

PITTSBURGH, PA., OCTOBER 12–15, 1959

Economic Aspects of Pressure and Temperature as They Relate to Turbine Generators

I. H. LANDES

MANUFACTURERS have the experience and design knowledge necessary to build turbines for any initial steam conditions that might be considered for the paper industry in the forseeable future. The first cost of equipment utilizing higher steam pressures and temperatures is usually higher, but on the other hand the fuel costs are greatly reduced.

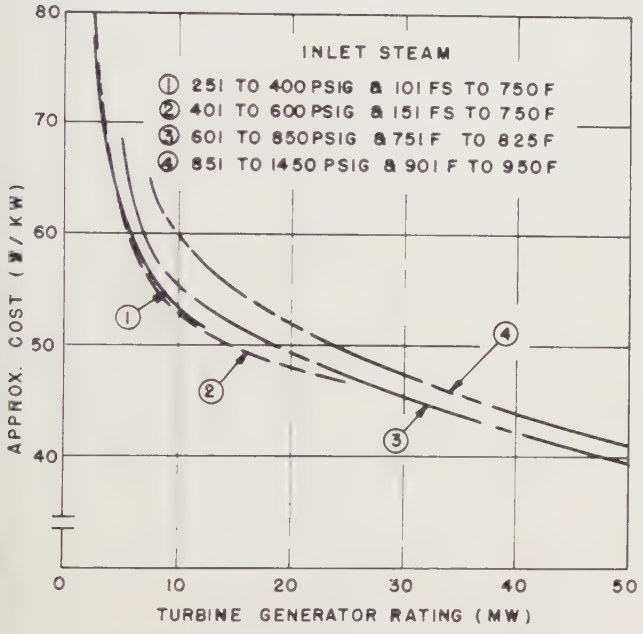


Fig. 1. Approximate cost of condensing turbine-generator units

The selection of the optimum steam condition requires a detailed economic evaluation based on many factors: cost of fuel, load factor, cost of equipment, size of the mill, return on investment, etc. My part in this program is to give you data on the effect that initial steam conditions have upon turbine costs and upon fuel savings.

Higher steam pressures and temperatures require design refinements and the use of special alloys, which increase the price of the turbine. But the added cost is surely not prohibitive. For example, as shown in Fig. 1, a 20,000-kw. condensing unit with 1450 p.s.i.g. inlet steam costs approximately $4 per kilowatt or $80,000 more than a 600 p.s.i.g. unit.

Figure 2 shows the same data for noncondensing turbine generators. Again comparing 600 and 1450 p.s.i.g. inlet conditions, the cost differential for a 20,000-kw. unit would be $9.50 per kilowatt or $190,000. Both condensing and noncondensing unit can be provided with automatic extraction for a nominal price addition.

The range of steam conditions specified in the majority of industrial applications is shown in Fig. 3. These data are plotted on the basis of turbine inlet steam flow because this is a more direct measure of the size of turbine parts than kilowatt rating. The approximate kilowatt rating of straight condensing turbines is also plotted along the horizontal axis. For noncondensing and automatic-extraction turbines, the rating at which higher initial steam conditions become economic may be as low as one half that for a straight-condensing turbine with the same steam conditions. This is due to the higher inlet steam flow for these units.

The paper industry has traditionally used noncondensing and extraction turbines to produce low cost by-product kilowatts. Figure 4 shows the approximate by-product power

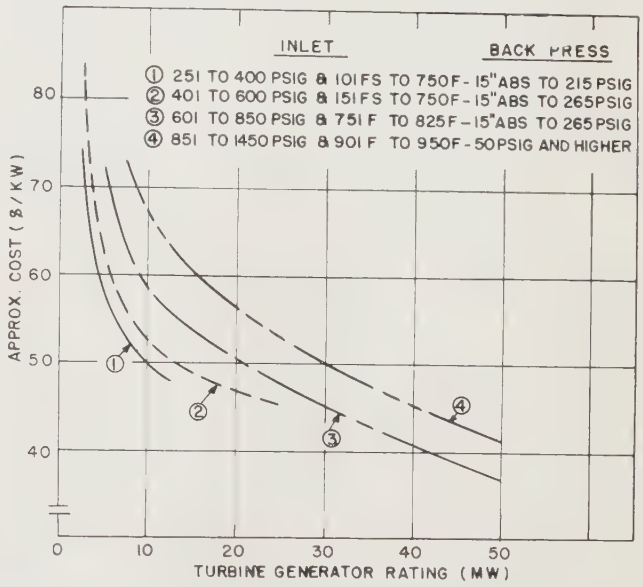

INLET
BACK PRESS
① 251 TO 400 PSIG & 101 F S TO 750 F - 15" ABS TO 215 PSIG
② 401 TO 600 PSIG & 151 F S TO 750 F - 15" ABS TO 265 PSIG
③ 601 TO 850 PSIG & 751 F TO 825 F - 15" ABS TO 265 PSIG
④ 851 TO 1450 PSIG & 901 F TO 950 F - 50 PSIG AND HIGHER
APPROX. COST ($/KW)
TURBINE GENERATOR RATING (MW)
80
70
60
50
40
0
10
20
30
40
50

Fig. 2. Approximate cost of noncondensing turbine-generator units

that can be generated for each 100,000 lb. per hr. of steam expanded through a noncondensing turbine. The same data would apply to the steam being extracted from an automatic extraction turbine, except the by-product kilowatt output would be reduced slightly—3 to 6% for a single automatic extraction turbine and 5 to 8% for a double automatic extraction unit. This reduction in by-product output is usually insignificant when the added operating flexibility of the extraction turbine is factored into the evaluation.

Notice the significant gains available for the higher inlet steam conditions. For example, when 200 p.s.i.g. process steam is required approximately three times as much by-product is available if 1450-p.s.i.g. inlet steam is used instead of 400-p.s.i.g. steam.

Figure 5 shows the heat rate performance of generating stations for various inlet steam conditions and for varying

I. H. LANDES, General Electric Co., Schenectady, N. Y.

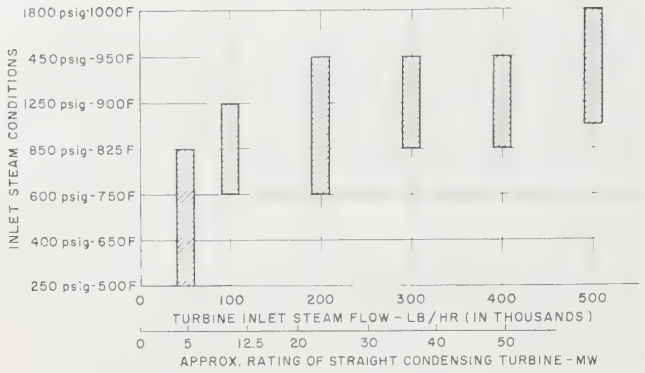


Fig. 3. Range of initial steam conditions normally selected for industrial steam turbines

amounts of process steam flow. This particular set of curves applies to a 15,625 kw., double automatic extraction, condensing turbine with extraction at 50 and 150 p.s.i.g. However, the same general characteristics apply to any plant having a combination of noncondensing, extraction, and condensing turbines.

You will notice that the fuel chargeable to power generation is reduced with higher inlet conditions an/or increased process steam load. When initial steam conditions are selected high enough to permit generation of all electric power in straight, noncondensing or automatic extraction, noncondensing turbines, power can be generated for as low as 4600 B.t.u. per kw-hr. The heat to process is not chargeable to power, and there is no loss of heat to the condenser. Therefore, the only items chargeable to power generation are boiler losses, auxiliary power losses and mechanical and electrical losses in the turbine generator.

The heat rate for a straight condensing cycle is in the range of 12,000 B.t.u. per kw-hr. to 15,000 which is approximately three times the noncondensing heat rate. So you see, the major gain from operating at higher pressure and temperature results from producing more by-product kilowatts for a given amount of process steam.

These savings can best be illustrated by considering a specific example. Let us assume we are considering the installation of a 12,500-kw., automatic extraction, condensing turbine generator unit in a system requiring 11,000 kw. of net generation and using 150,000 lb. per hr. of dry process steam. The annual fuel costs for various inlet conditions and process pressure levels are summarized in Fig. 6. These calculations have assumed a fuel cost of 30 cents per million B.t.u. and 8000 hrs. operation a year. We have also assumed that the heat used in the process is constant regardless of pressure level.

You will notice that there is a substantial saving in fuel cost when higher pressures and temperatures are utilized.

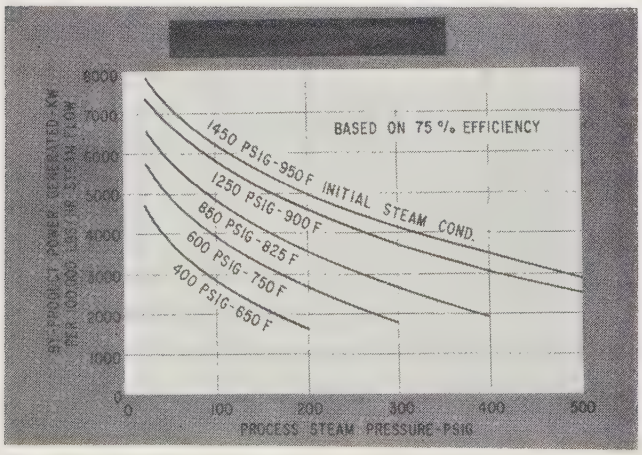


Fig. 4. By-product power that can be generated when steam is expanded from various initial steam conditions to the lower pressures required for process

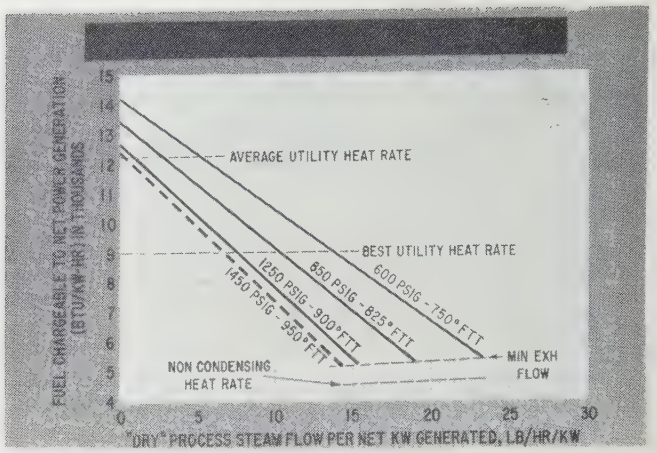


Fig. 5. Effect of initial steam conditions on the fuel chargeable to net power with automatic-extraction condensing turbines generating electric power and supplying steam for process and extraction for full feed-water heating (one-half flow at 50 and one-half at 150 p.s.i.g.)

For example, if 150 p.s.i.g. process steam is required, when compared to a 1450 p.s.i.g. system, the annual fuel costs are approximately \$55,000 more for an 850-p.s.i.g. system, \$95,000 more for a 600-p.s.i.g., system, and \$160,000 more for a 400-p.s.i.g. system. And of course, if the fuel cost and/or the load factor were higher than those assumed in our calculations, the savings would be increased proportionately. In addition to this, the condenser sizing and cooling water facilities will be slightly smaller with the higher pressure system.

In selecting the steam conditions, the fuel savings must be weighed against the incremental investment for the higher pressure equipment. I have given you some typical cost data for the turbine generator, and I believe the other panelists will fill you in on other important cost factors which will help you in selecting the most economical system.

Presented at the 14th Engineering Conference of the Technical Association of the Pulp and Paper Industry, held in Pittsburgh, Pa., Oct. 12–15, 1959.

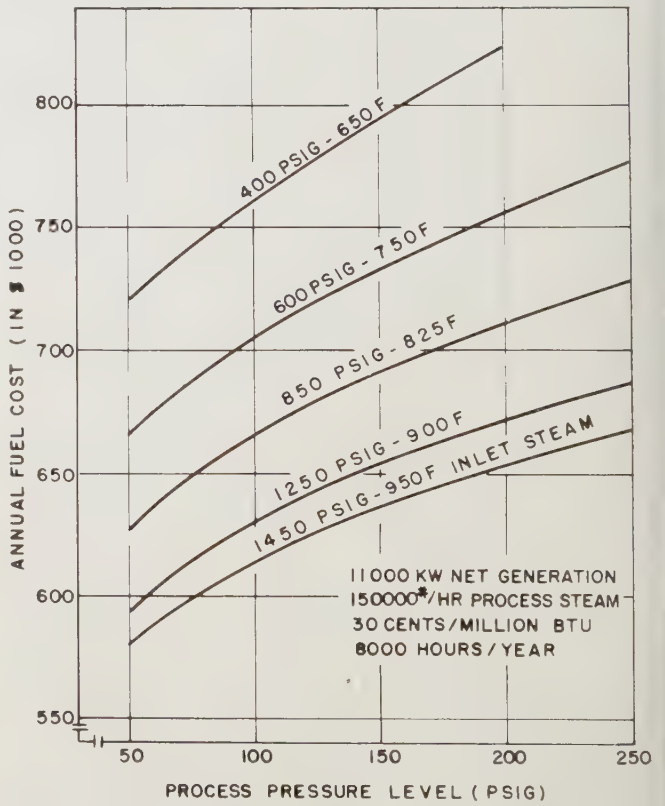


Fig. 6. Fuel costs as affected by inlet steam conditions and process pressure level

Economic Aspects of Pressures and Temperatures for Pulp and Paper Mill Power Plants as Related to Power Boilers*

H. B. WALLACE, JR.

THE overall problem of selecting equipment for pulp and paper mill steam electric power plants has many and varied considerations of which industry personnel, consultants, and manufacturers who have been involved with such plants over the years are well aware. The subtitle for this portion of this panel discussion specifies merely one of the many areas for evaluation when planning new plant equipment.

Up to the point of studying the effect of pressures and temperatures on the capital cost of power boilers, some of the more important items, which should be available include:

Steam and electric energy use and requirements have been tabulated with reasonable accuracy for present and long-term needs with heat balances for as many case studies as represent reasonable possibilities of attainment. Pressure and temperature levels contemplated by the heat balance should be in conformity with the generally accepted standards of available equipment.

Fuel characteristics for power boilers have been defined within reasonable limits of accuracy.

Cost of money has been established, as well as other fixed charges where new investment is involved.

Operating and maintenance costs and data for various pressure-temperature combinations and methods of firing have been estimated or projected from past mill experience.

There are no published price lists for power boilers. Therefore, it is desirable to obtain assistance of several manufacturers in obtaining budget or preliminary prices for the equipment consistent with the cases to be studied in the economic evaluation of equipment selection prior to the writing of purchase specifications. Steam generating equipment is essentially tailor-made to individual requirements covering a wide variery of purchasing practices as to scope of equipment and services comprising the boiler contract; as to degrees of complexity or simplicity of auxiliary hardware and exteriors; as to variations in fuel characteristics and requirements for fuel combinations; as to initial and possibly future pressure-temperature and fuel uses; as to steam generator efficiency—to mention a few. Even at the preliminary stages of equipment evaluations, it is considered important to pinpoint the many variables confronting the boiler manufacturer in his selection of equipment for the specific application, as generalities can often confuse the issue.

In addition to tangible items of evaluation, there is one important intangible which warrants comment. That is availability or reliability of steam generating equipment. Power boilers manufactured by leading American suppliers may be expected to have an exceptionally high degree of availability. Experience gained in the design and operation of monumental installations in the greatest utility system in the world is available to operators of industrial type plants where size, pressure-temperature, and efficiency requirements are less stringent. Availability of steam generating equipment to the industrial plant user is of more serious concern than to the utility user. The cost of an outage of a unit to both is costly and serious. However, through interconnection with adjacent utilities, the ability of the utility to sell his product to his customers without serious impairment of service continuity is less likely than in an industry like the pulp and paper industry, where loss of power or steam capacity could mean loss of production and have detrimental effect on customers. Recognizing this situation, it may be stated with confidence that reputable steam generator manufacturers are able to meet the requirements of your industry for power boilers in unit sizes well in excess of 500,000 lb. of steam per hour, in standard pressure-temperature combinations to 1500 p.s.i., 950°F., having wide fuel firing flexibility, burning oil, gas or coal or combinations thereof. Consequently, serious consideration may be given elevated pressures and temperatures with equipment having high availability and long life expectancy. This statement is made in the interest that the objective is to secure not necessarily the lowest B.t.u. per kw.-hr., nor the least expensive plant in terms of dollars per kilowatt, but the lowest overall cost per kilowatt-hour.

Data are not readily available on the relationship between pressure-temperature levels and production expense. By production expense, we refer to operating labor, supervision and engineering; operation supplies and expenses, including water; and maintenance labor, material, and expenses. Not included are fuel costs, depreciation, taxes, interest, etc. While many mills and utilities keep excellent records of boiler room operations, local conditions vary so widely that it is difficult, indeed, to assess charges for such costs as are influenced by choice of cycle conditions. The higher the pressure and temperature, however, the higher the production expenses will be. The margin of difference for production expense between a unit operating at 450 p.s.i.g., 750°F. and one operating at 1500 p.s.i.g., 950°F. is small, but a margin does exist. The power engineer may have prior experience upon which to extrapolate costs to apply to the higher pressure-temperature levels under investigation or have access to information from other mills.

Fuel cost is a function of heat added to the water to produce steam at the cycle conditions of pressure and temperature and the steam generator efficiency. There is no relationship between the efficiency of the unit and the operating pressure-temperature levels. Efficiency is a function of the temperature of gases leaving the unit, principally. Capital investment cost of steam generating equipment, however, is related to efficiency and to the method of firing for any given cycle condition.

In establishing unit prices from which to determine the captial cost increments which follow, a range of efficiency values as here tabulated have been assumed:

Method of firing	*Power boiler efficiency, %*
Fuel oil	85–86
Natural gas	80–81
Pulverized bituminous coa	86–88
Spreader stoker bituminous coa	81–82

Local conditions will dictate the final efficiency specification requirement for new steam generating equipment. The foregoing is intended merely to establish a benchmark. It might be pointed out that a correlation theoretically exists in the value of production expenses with efficiency, but here again, data are not readily available in usable form.

Power and steam consumption of auxiliary components such as boiler feed pumps, fuel oil pumping and heating sets, soot blowers, solid fuel preparation and handling equipment, bottom and fly ash handling equipment and mechanical draft equipment may vary with pressure-temperature considerations. For closer refinement of economic evaluations, the effect should be studied for the specific items of controlling equipment.

"Break points" in the cost of steam generating equipment based on ranges of operating pressures and temperatures are perhaps not as well defined as one might think. There are variations between boiler manufacturers by virtue of the individualistic approach to boiler design and the degree of standardization of product. Boiler manufacturers have

H. B. WALLACE, JR., Manager, Equipment Division Sales, Foster Wheeler Corp., New York 19, N. Y.

* Panel Discussion, Steam and Power Committee Session of the 14th Engineering Conference of the Technical Association of the Pulp and Paper Industry, held in Pittsburgh, Pa., Oct. 12–15, 1959.

Table I. Average Incremental Capital Cost Increase for Power Boilers for Various Pressure-Temperature Cycle Conditions

Cycle conditions			Method of firing		
	Temperature °F.			Bituminous coal	
P.s.i.g.	Steam	Feed	Oil or gas, %	pulverized %	Spreader stoker, %
A—450	750	340	Base	Base	Base
B—650	825	360	6–8	6–8	6–8
C—900	900	380	35–40	20–25	20–25
D—1300	950	440	65–70	45–50	45–50
E—1500	950	460	90–100	80–85	80–85

NOTES:

1. Tabular data are above the base cycle conditions of 450 p.s.i.g. 750°F. at the superheater outlet and entering feedwater temperature at 340°F.
2. Scope of equipment, see text.
3. Increases are on delivered and erected basis.
4. Capacity range 100,000 to 500,000 lb. steam per hour.

approached the problem of standardization over many years for the purpose of making equipment available at competitively attractive prices. Standardization essentially comprises the boiler, furnace, and superheater configurations and most details of construction. Standardization of heat recovery equipment and hardware associated with the complete steam generating unit has not progressed to as high a degree. Duplication of an existing engineered unit would have the effect of indicating a "break point" and might certainly be to the purchaser's benefit to study more closely.

Boiler costs are dictated by pressure levels consistent with requirements of the ASME Boiler Code which establishes the basis for determining the thicknesses of drums, headers, tubes, and piping. The cost of valving subjected to boiler pressure also varies with the design pressure. Boiler costs are dictated by temperature levels again through consideration of the ASME Boiler Code, but more particularly by virtue of the manufacturer's own design criteria frequently in excess of code used for determining material choices for superheater tubing and headers, as well as thicknesses of such tubing and headers as a function of the metal temperatures encountered. As an added factor, boiler cost influence is introduced if regulation of steam temperature over a range of operating load from partial to full load is required. Superheater costs mount with rapidity with increased use of alloys associated with higher steam temperatures.

Table I shows the average incremental capital cost increase for power boilers for various pressure-temperature combinations and methods of firing. For purposes of this tabulation, we considered boiler capacities from 100,000 to 500,000 lb. of steam per hour based on a scope of equipment generally comprising the steam generator proper, mechanical draft equipment with drives, firing equipment, economizers, soot blowers, combustion control equipment, flues and ducts, and structural steel. Excluded were platforms and stairways, fuel handling equipment, ash disposal equipment, breechings, stacks, electrical work, foundations, and buildings. Note that variations are wider in the case of oil- or gas-fired units. This is so because of the higher percentage of parts subject to cost change with pressure than in the case of coal-fired units. A further factor which will alter the average incremental capital cost is feedwater temperature which will also influence the fuel cost.

In conclusion, it is urged that full advantage be taken of the facilities of the boiler manufacturers to secure more definitive information to assist in making economic evaluations as accurate as possible.

Presented at the 14th Engineering Conference of the Technical Association of the Pulp and Pnper Industry, held in Pittsburgh, Pa., Oct. 12–15, 1959

Economic Aspects of Pressure and Temperature as They Relate to Chemical Recovery Units

F. W. HOCHMUTH and W. J. DARMSTADT

FROM a practical standpoint, pulp and paper mill steam-power cycles must be compared on the basis of reliability, as well as on costs of steam and power produced. The purpose of this discussion is to present data relating to the economics in the selection of chemical recovery units for various steam conditions.

On the basis of overall plant thermal efficiency, the ideal situation for a power plant serving a pulp or paper mill is achieved when all power required for the mill can be generated from steam needed for process, without resorting to purchased power or power generated in a condensing turbine to force a power balance. For various reasons a true balance can never

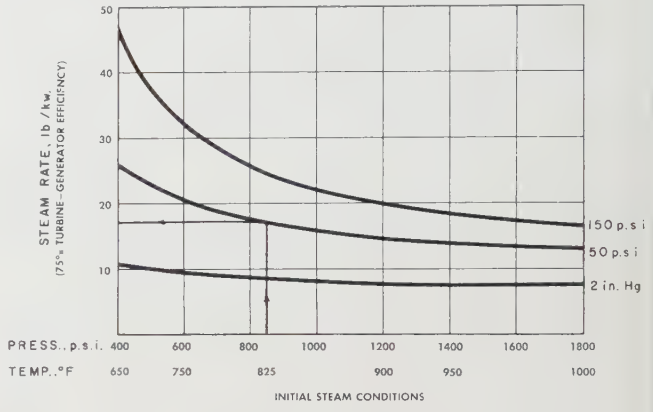


Fig. 1. Turbine steam rate vs. initial steam conditions for various extraction or back pressures

be achieved, therefore some compromise must be made through the use of purchased power, generation of condensing power, or pressure-temperature reducing stations.

The principles of improving the efficiency of thermal power stations by increasing steam pressure and temperature are well known. These same principles apply to industrial power plant installations where the major portion of the steam generated is condensed in process equipment. Pulp and paper mills have made wide use of this concept when the existing power systems require upgrading or when new mills are designed which require a higher ratio of power-to-steam

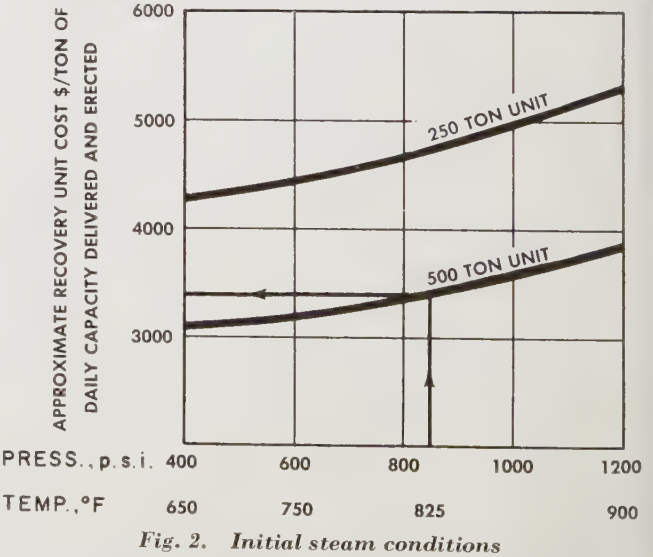


Fig. 2. Initial steam conditions

F. W. HOCHMUTH, Combustion Engineering, Inc., New York, N. Y.; W. J. DARMSTADT, Babcock & Wilcox Co., Barberton, Ohio.

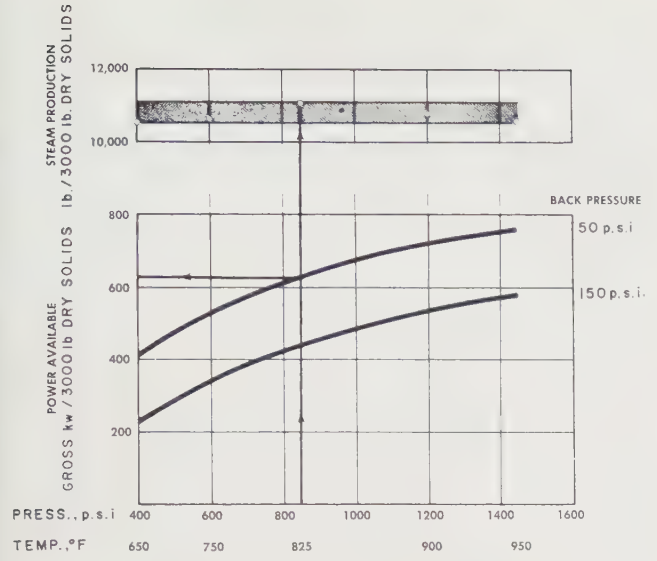


Fig. 3. Initial steam conditions

than can be obtained from steam-power cycles already in common use.

Figure 1 illustrates the influence that initial steam pressure and temperature has on steam rates for the usual turbine extraction or back pressures. The rate of improvement of steam rate (lb. per kw.) decreases as pressure and temperature increases.

Figure 2 shows the approximate cost of black liquor recovery units for standard combinations of steam pressure and temperature. Data are given on a dollars per ton pulp basis for recovery units capable of processing liquor solids of 250 and 500 tons daily pulp capacity. The ton unit has been used since chemical recovery units are sized by process load rather than steam generated. In all cases, it has been assumed that 3000 lb. black liquor solids are produced per ton pulp and that these solids have a heating value (H.H.V.) of 6500 B.t.u. per pound; furthermore, that black liquor is concentrated to 50% solids before delivery to the recovery units.

These curves illustrate that the cost of recovery units increases most rapidly in that range of pressure and temperature where the turbine steam rate improvement is diminishing. In going from 900 p.s.i. and 825°F., to 1200 p.s.i. and 900°F., steam temperature control must be introduced, more expensive materials are needed for the superheater, and other design refinements are required, all of which are not needed for the lower pressures and temperatures. These features account for the increase in costs that is shown in this range.

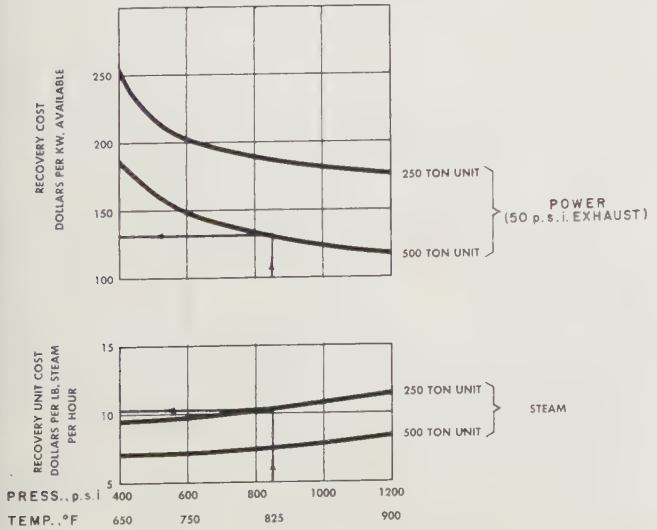


Fig. 4. Initial steam conditions

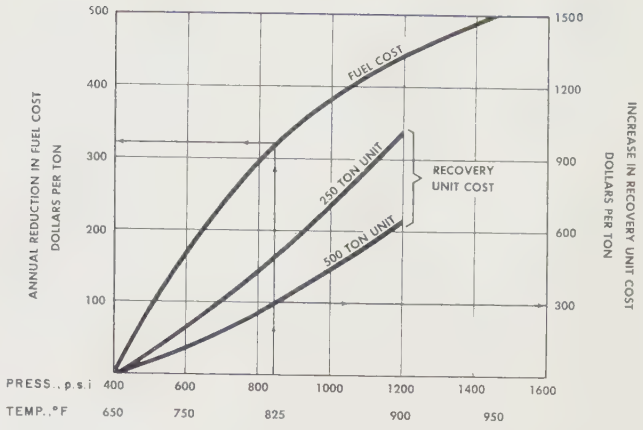
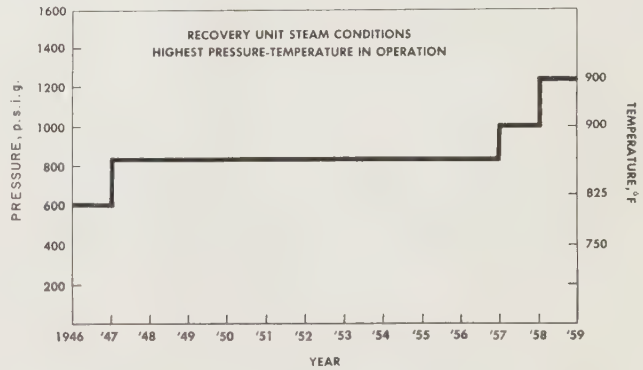


Fig. 5. Initial steam conditions

The gross steam and power available from each unit ton or 3000 lb. dry solids is shown in Fig. 3. Power availability is shown for the two extractions or back pressure conditions most commonly used. It is interesting to note that the gross steam output varies only about 5% for the range of steam conditions considered. This is owing to the higher feedwater temperatures that are used with the high pressure cycles. Net heat available for process actually decreases slightly as initial steam pressures and temperatures increase by an amount to the heat equivalent of the additional power generated and the additional steam required to clean the added superheater surfaces of the high temperature recovery unit.

Figure 4 combines the data given in Figs. 1 and 2 to show the cost of recovery units on the basis of dollars per pound of steam, and dollars per kilowatt of available power. For the sake of simplicity only one turbine extraction or exhaust pressure has been shown. Recovery unit costs, on a per pound steam basis, are considerably higher than those for standard steam generators fired with conventional fuels. Black liquor ranks as an extremely poor fuel because of its high ash content and low ash fusion temperature. This makes it necessary to use large furnaces in order to obtain low gas temperatures. The superheater, boiler, and other heat recovery surface operate at relatively low absorption rates owing to the gas side deposits inherent with this fuel.

Figure 5 shows the relationship between the annual reduction in fuel costs and increase in recovery unit costs for



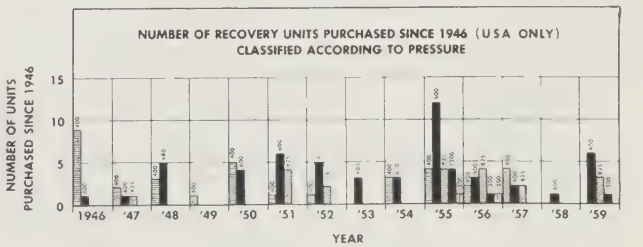

NUMBER OF RECOVERY UNITS PURCHASED SINCE 1946 (USA ONLY)
CLASSIFIED ACCORDING TO PRESSURE
NUMBER OF UNITS PURCHASED SINCE 1946
15
10
5
0
1946 '47 '48 '49 '50 '51 '52 '53 '54 '55 '56 '57 '58 '59
YEAR

Fig. 6

various conditions. These are given as incremental costs per unit of capacity using 450 p.s.i. and 600°F. steam conditions as a base. The basis for calculating reduced fuel costs assumes that any deficiency in mill power would be generated by condensing turbines operating 8000 hr. per year with condenser pressure 2 in. Hg, fuel cost 30 cents per million B.t.u. and a boiler efficiency of 85%. The fuel savings shown represent gross values and do not take into account any change in auxiliary power requirements. An economic study should also take into account the savings realized from other boilers using conventional fuels, as well as the additional costs for feedwater treatment, high pressure piping systems, and other items required for conditions being compared.

The foregoing information has dealt with equipment costs and potential savings. Other factors governing the selection of steam conditions listed in order of precedence are dependability, initial cost, serviceability, and efficiency. In the final analysis the major emphasis for pulp mill operation must be placed on dependability.

Figure 6 illustrates how recovery unit pressures and temperatures have advanced since 1946. The predominance of experience is in pressure and temperature up to 600 p.s.i. and 750°F. with a substantial amount at 850 p.s.i. and 825°F. and, more recently, several units of 1200 p.s.i. and 900°F. and above have been placed in operation. Recovery units designed for steam conditions up to and including 850 p.s.i. and 825°F. have proved completely commercially reliable when properly operated.

The operating experience of units designed for 1200 p.s.i. and above and 900°F. at the superheater outlet has been favorable. No operating problems directly attributed to the high steam pressure and high steam temperature have been encountered.

In summary, it should not be assumed that recovery units can arbitrarily be specified, designed, and operated at pressures and temperatures which are common to public utility and some industrial power installation, without particular emphasis to operating conditions which are singularly inherent to recovery units. As mentioned before, the fuel is a by-product of the process and, in comparison to other fuel it is most unfavorable. Because of the physical and chemical composition of black liquor, this by-product fuel imposes design and operating limitations which are not generally associated with oil, coal, or gas. As these limits are approached, the supplier-designer and operator must be increasingly vigilant of all conditions which contribute to maintenance and operation of recovery units.

Presented at the 14th Engineering Conference of the Technical Association of the Pulp and Paper Industry, held in Pittsburgh, Pa., Oct. 12–15, 1959.

Economic Aspects of Pressure and Temperature as They Relate to Mill Operation

T. J. JUDGE

The other members of the panel, Messrs. Landes, Wallace, Darmstadt, and Hochmuth, have just presented their views on the economical aspects of high pressure and high temperature steam, as it relates to major power plant equipment. They have illustrated the economical advantages of producing steam at a high initial pressure and temperature and reducing it to the process pressure through turbines. Electrical energy can be produced at operating costs less than one-third the cost for condensing units. It is my purpose to discuss some of the aspects of higher pressure and temperature as they relate to power plant personnel, equipment maintenance, and operating functions.

T. J. Judge, International Paper Co., Mobile, Ala.

Operating problems of higher pressure and temperature plants are somewhat different in nature than in the low pressure plants. They must be carefully analyzed and satisfactorily resolved. A program for training operating and maintenance personnel should be initiated to teach the new principles of operation and the new maintenance procedures that pertain to high pressure equipment. The management and technical supervision must also be familiar with the new requirements of safety, maintenance procedures and operating practices. Other important operating factors of higher pressure and temperature plants include the longer time needed for starting up and shutting down, and the importance of providing adequate treatment and accurate analysis of boiler water.

First, I would like to give a brief discussion of its effect on personnel. The personnel in high pressure and temperature plants need a detailed knowledge of the special operating conditions and equipment care. Better trained personnel is necessary because of the heavier constructed equipment, the extra automatic control equipment required, the use of more precise safety devices and the necessity of accurately analyzing and maintaining good boiler water conditions.

The operating personnel must better understand the methods of warming up equipment and piping during startup periods, as well as the attention required for shutting down. They must study and learn the functions of all automatic control equipment and be able to safely switch any operating equipment from automatic to manual control and back.

The maintenance personnel must learn to work with the alloy metals used in the high temperature plants. For example, the technique used to weld alloy piping or alloy superheater tubing is much more exacting and precise than for carbon steel. The alloy bolting materials used on high-pressure pipe flanges and heavy-equipment flanges must be loosened carefully to avoid galling. When tightening the bolts, an exact stress must be applied. With high pressure and temperature, undue breakage will occur if overstressed and flange leakage is more prominent with insufficient tension. Welders must be trained to use the latest welding techniques. Repairmen must learn the special instructions for repairing and adjusting the high pressure safety devices, as well as the instruments and automatic controls. Special care and precision must be used to disassemble, inspect, repair or adjust the high pressure equipment.

Better maintenance programs and practices are absolutely necessary in the high pressure and temperature plants. Good preventive maintenance is of the utmost importance. Making repairs in the high-pressure plants is more tedious and exacting than in the low pressure ones but, usually, it is no more difficult. The equipment is of necessity constructed of heavier materials that provide better safety factors. Also, the better materials are more resistent to corrosion and other deteriorating conditions. The boilers use heavier drum plates and thicker tubing. The turbines have thick cylinder castings with extremely heavy flanges. The piping with heavy wall thickness is welded at most connections and the few flanges used are heavily constructed. The valves are equipped with alloy trim and use special packing or seals, which seldom give trouble. All of this high-pressure equipment will require more care and more time for disassembly and inspection but the frequency of making repairs is generally less.

The heavier constructed boilers with their more complicated tube arrangement are not as easily cleaned with mechanical devices. Scale is most generally removed with acid solutions, a process requiring special skill. Also, superheater and boiler tubing is generally replaced or repaired by welding on which special welding technique is required.

The high-pressure turbines, because of their heavier construction and precision manufacture, operate very smoothly and with little difficulty. The usual periodic internal inspection is necessary to determine the condition of buckets,

nozzles, seals, etc., in the steam path. High-pressure turbines, being heavier constructed, are more difficult to open up for inspection. Heavy flange bolts must be heated and carefully loosened. Likewise, time required to re-assemble and tighten bolts is much longer. There has been a reduction in the scaling properties that carry over with the steam and deposit in the turbines. Improved operating conditions are such that frequency of internal turbine inspection in the better plants has been extended to periods as long as 4 years.

The boiler feed pumps are also heavily constructed to withstand the high internal pressure and the greater forces exerted by piping expansion. Here also is very little deterioration or erosion of the special alloy materials used. The need for internal inspection is seldom evident. Trouble is apparent only when vibration increases, efficiency falls off, or the seals start leaking excessively.

All miscellaneous equipment should be kept as near as possible in a condition equivalent to new. It is particularly essential to keep the automatic control equipment, instruments and safety devices in good repair and functioning properly. Good efficiency and good economy can be obtained only by keeping them properly adjusted and in continuous operation.

The operating problems in the high pressure and temperature plants are very little different from those of low pressure. One of the main differences is the extreme care required in starting up and shutting down equipment, particularly the boilers and turbines.

To bring a 1200-lb. boiler up to pressure usually requires three or four times longer than a boiler in the 400-lb. range. Likewise, in shutting down, they must be allowed to cool slowly before the boiler water is drained or before the furnace is entered. These special attentions naturally extend the time required for making inspections and repairs. They also increase the difficulty of shutting down for short periods, such as on Sunday or a holiday.

The turbine similarly requires more time and diligence for the starting-up and shutting-down procedures. Proper heat distribution and expansion must be assured. Turbines designed to operate with temperatures of 950°F. at the inlet end and 110°F. at the exhaust, often exhibit vibration spells during startup. As a unit is shut down, the heat from the high-temperature end will dissipate into the low-temperature end to cause types of distortion different from those in normal operation. To avoid excessive shaft distortion, the turbine rotor must be kept rolling slowly on the turning gear for several hours after shutdown. The oil must also be circulated for a similar period to remove the heat as it is conducted from heavy castings and forgings to the bearings. These problems present no particular difficulty if normal operating procedures are followed but when emergencies occur, the possibility of damage to the unit increases with the higher temperatures.

The well-designed automatic control equipment, which is generally installed with high pressure and temperature plants, contributes many benefits to the convenience of operation. Some plants use central, control-room areas to coordinate and regulate all operation. One operator can observe all operating conditions and be assured that efficient ratio of fuel and air, constant superheat, necessary steam distribution to hold desired process pressure, correct frequency, and a well-divided generator load is maintained. The automatic control equipment must be kept in operation continuously. The operator should never resort to manual control except in cases of emergency.

Paper mill power plants burn a large variety of fuels. The waste heat fuels, such as bark and black liquor, are supplemented by purchased fuels, such as gas, oil, and coal. Each fuel has a different effect in the superheater; therefore, steam temperature will vary with type of fuel burned. Different combinations of bark, gas, oil, or coal can cause as much as 10% difference in steam temperature at identical boiler loads. To compensate for this variable, the superheater is designed for the worst firing conditions. The heating surface is sufficient to obtain design temperature at steam loads of approximately 65 to 75% of boiler rating. A method of attemporation is used to prevent excessive temperature when operating at higher boiler loads or when burning different fuels.

The principles of firing black liquor are the same for high pressure recovery boilers as for low pressure units. However, the corrosive attack of black liquor furnace gases on metal becomes worse as the metal temperature increases. Recovery boiler superheaters are presently limited to steam temperature of 900°F. One of the most difficult operating problems at this higher temperature occurs when the gas passage becomes partially plugged. Then, more of the gases will flow through the less restricted sections producing higher steam temperature in those tubes. This causes rapid tube corrosion, which will eventually result in a superheater tube failure. I know of one boiler designed for a steam temperature of 825°F. that had several tube failures because, in a few sections, the temperature was as high as 1000°F.

Since a large portion of the condensate is lost in process steam uses, makeup in the boiler feedwater will usually run between 40 and 60%. A good, pure makeup must be provided for the high pressure boilers. A two-stage demineralization plant provides an excellent effluent with all the qualities required for boiler water. Good well water can usually be treated through the demineralizers without any type of pretreatment or filtering. In mills where surface water is treated for process use, a portion can usually be filtered and demineralized without further treatment. The plant is very simple to operate and requires practically no attention except when regenerating the exchange bed. The operating cost may seem to be excessively high, but after considering such factors as less internal boiler treatment, less boiler blowdown and reduced carryover with steam, it can be justified even in many low pressure plants. One of the troubles of boiler water conditioning originates in the mill condensate system. Excessive iron oxide is picked up by the condensate, particularly after the mill equipment has been out of service for several days. As the boiler operating pressure is increased, the attack of iron oxide scale on the boiler metal becomes more active. The iron returned with the condensate must be kept to an absolute minimum. Oxidation in the condensate system must be reduced as much as possible and the iron picked up should be removed before it enters the boiler. Several methods for reducing iron pickup are presently being studied and it is hoped that a simple solution will be found soon.

With the many variables in process steam flows and electrical demand, an ideal balance of producing electricity with process steam cannot be maintained throughout all operating conditions. These variations in either steam or electricity can be caused by changes in paper grades, cold weather and cold water in winter as compared to summer, and the irregular operating schedule for some of the production equipment. It is the usual practice to design a power plant so a portion of electricity is generated with condensed steam. The percentage of condensing capacity, however, is reduced as the initial pressure and temperature is increased and much of the flexibility is lost. When a paper machine is shut down without reducing the electrical load, a surplus of low pressure steam will usually be turned to atmosphere.

Many paper mills are designed so process water can be used through the condenser. For some mills, the preheated process water has economical advantages; for others, it is detrimental. Surface water temperature naturally follows the weather temperatures and where large quantities are used for mill process, the economics of using the turbine condenser to preheat in winter are evident. In summer, the water will probably be too hot and evaporative cooling towers must be used or more surface water will be required.

We have reviewed operating conditions in a number of plants to determine the most practical and economical level of initial pressure and temperature. In plants designed to produce machine dried pulp, particularly bleached pulp, it is possible to generate all of the electrical power required with process steam. Such plants require use of reducing and desuperheating stations continuously. Other plants, such as those producing groundwood pulp and newsprint, have a high electrical load in relation to the process steam. Many of these plants will produce more than 50% of their power with condensing steam, even using the highest practical pressure and temperature level.

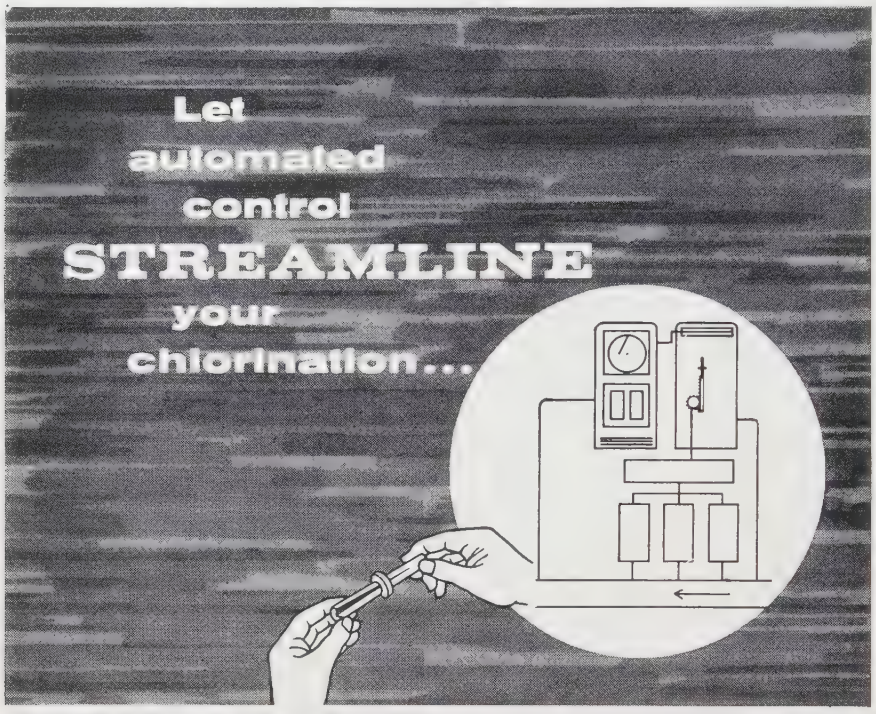
Standards of pressure and temperature have been established by equipment and piping manufacturers and the equipment cost naturally varies according to these. After reviewing the total construction cost and how this varies, it can be assumed that economical groups of steam pressure and temperaturecan be established. There is very little variation in total construction cost at any pressure or temperature within a group. Therefore, the highest pressure and temperature in a particular group would be selected. In my opinion, the economical grouping and the most practical steam condition in each would be approximately as follows:

1. 400 p.s.i.g., 750°F. TT
2. 600 p.s.i.g., 750°F. TT
3. 850 p.s.i.g., 825°F. TT
4. 1250 p.s.i.g., 900°F. TT
5. 1250 p.s.i.g., 950°F. TT*
6. 1500 p.s.i.g., 1000°F. TT*

It is our conclusion that high pressure and temperature in the paper mill power plant does not present undue operating problems. This is particularly true if the operating and maintenance personnel is properly trained and if good qualified technical supervision is provided. The equipment installed in today's high pressure and temperature plant is much better designed and constructed. Better operation and maintenance can be expected. The public utility industry has used higher pressures and temperatures for many years. Their operating experience should be proof that operation and maintenance is not difficult. It is reasonable to assume that higher pressure and temperature steam in the paper mill power plant has very little effect on the overall economy of operation other than lowering the cost of electrical generation. The operating cost of some items may increase but others will be lower. For example, the increased cost of training personnel is more than paid by the improvement in operating efficiency, and the higher cost of repair material is offset by a reduced amount of repairs. The operator, with good equipment and good maintenance facilities can carry out his assignment with the best economical results and the most reliable performance expected.

* Recovery boiler steam temperature is limited to 900°F. Higher temperature at the turbine inlet can be obtained from power boilers only, or by blending the 900°F. recovery-boiler steam with higher temperature from power boilers.

Presented at the 14th Engineering Conference of the Technical Association of the Pulp and Paper Industry, held in Pittsburgh, Pa., Oct. 12–15, 1959.



W&T COMPOUND-LOOP CONTROL

With automation by Wallace & Tiernan your chlorination system controls itself . . . needs almost no attention. With Compound-loop Control, the residual you select is maintained, no matter how much water flow or chlorine demand changes. You're always sure of water quality.

W&T Compound-loop Control means true process control. Because it analyzes the end result and feeds back information which monitors your chlorinator, Compound-loop Control successfully achieves a closed-loop system. This means an operating range of greater than 100 to 1, plus round-the-clock supervision without extra labor.

And you can control free or total residual . . . use electric, pneumatic, or variable vacuum signals. W&T Compound-loop Control can be tailored to the physical layout of your system, your flow-metering equipment, your plant hydraulics. You build or convert to automation with maximum convenience, minimum expense.

For more information, write Dept. S-141.91

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

Fifteenth

Engineering Conference

Robert Meyer Hotel

Jacksonville, Fla.,

Oct. 21–28, 1960

Chlorine Consumption of Pulp

Proposed Revision of TAPPI Standard T 202 m-45

(THIS STANDARD IS UNDER THE JURISDICTION OF THE CHEMICAL METHODS COMMITTEE)

THIS is essentially the Roe chlorination method (*1*) as modified by Johansson (*2*) and subsequently by Mitchell (*3*). It can be used to indicate the degree of cooking of unbleached sulfite, sulfate soda, or NSSC pulps.

APPARATUS

1. *Reaction Apparatus* (shown in Fig. 1). The gas burst A has a capacity of 120 ml. and is graduated in 0.2-ml. divisions. It is connected by a 2-mm. bore glass capillary tubing through stopcock S_2 to an upper, ungraduated chamber or reservoir D, of approximately 60-ml. capacity. Both are water-jacketed by glass tubes fitted with rubber bungs. Chamber D is closed by a ground-glass, closed-bottom, standard-taper stopper, and is connected by 2-mm. bore glass tubing and stopcock S_3 to a gas pipet C_1C_2. Buret A is also connected by 2-mm. bore tubing to S_1, a three-way cock through which dry chlorine gas may be introduced from a cylinder into the buret, or excess chlorine may be discharged to waste. Ground-glass ball-joint fittings are used to connect A, D, and C. Buret A is connected at the bottom with stout $^1/_4$-in. bore, neoprene tubing, about 4 ft. long, to a leveling bottle B. A calibrated thermometer T is suspended from the top rubber bung and is wholly immersed in the water in the jacket. The whole apparatus is appropriately mounted, including a sliding support for the leveling bottle B, so arranged that the bottle may be supported at any desired height. Means are also provided to continuously circulate water with a temperature of 25°C. through the two jackets.

Twin units would permit duplicate determinations to be made only a few minutes apart.

2. *Other Apparatus.* Small Buchner funnel and flask, barometer, exhaust hood.

3. *Other Materials.* Compressed air supply (not essential) and Silicone stopcock grease.

Note: Kel-F fluorocarbon lubricant has been found to be satisfactorily inert to chlorine; stopcocks so lubricated have seldom required attention. The grease is readily removed with acetone.

REAGENTS

A. *Calcium Chloride.* Nearly saturated solution of $CaCl_2$. Prepare a saturated solution and add 5% by volume of water.

B. *Chlorine,* cylinder of compressed gas.

TEST SPECIMEN

Take a representative sample of at least 4 g. of pulp and disintegrate thoroughly if not completely defibered. Acidify with dil. HCl to dissolve any carbonates present (e.g., $CaCO_3$). With the Buchner funnel and suction flask, make a sheet having a dry weight of about 2 g. and wash well with distilled water. Make and wash a second sheet and allow both sheets to dry together in the vicinity of the balance (preferably under constant temperature and humidity conditions). Determine the percentage of moisture in one of the

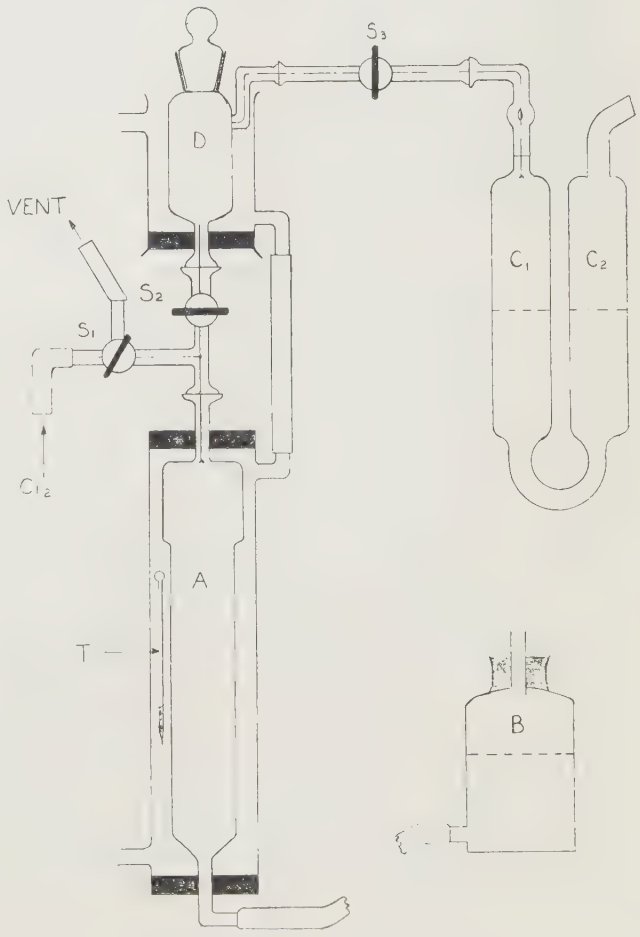


Fig. 1. Reaction apparatus

samples. Weigh, to the nearest mg., sufficient pulp from the other sheet which, it is estimated, will consume between 30 to 80 ml. of chlorine. (This will vary between 0.4 g. for a high yield chemical pulp to 2.0 g. for well cooked pulp.)

PROCEDURE

Assemble the apparatus in the exhaust hood with the reaction chamber D empty and turn on the 25°C. circulating water. Lubricate the stopper D, the ball-joints, and the stopcocks with the fluorocarbon grease. Fill the gas buret A, the tubing, and the bottom of leveling bottle B with sufficient $CaCl_2$ solution so that at least the connecting tubing remains full when the buret A is full. Place sufficient $CaCl_2$ solution in the gas pipet C so that 10 to 20 ml. remains in C_2 when C_1 and the tubing to S_3 are full. Saturate the $CaCl_2$ solution in buret A and bottle B by passing chlorine through S_1 (with S_2 closed) through A and the tubing to B, and then to waste through the hood. To saturate the solution in C_1, clamp the tubing between A and B, place the stopper in vessel D, open S_3, and pass chlorine through S_1, S_2, D, S_3, C_1, and then C_2 to waste through the hood. Make sure that all the balljoints are properly seated, that the apparatus is leakproof, and that the $CaCl_2$ solution is completely saturated with chlorine. This is ascertained by running a blank test overnight, using the chlorine but no specimen. There should be no resulting change in the volume of the added chlorine after this operation. The $CaCl_2$ solutions need to be freshly saturated with chlorine only at the commencement of a series of successively performed tests, or after a stand-by interval exceeding 1hr.

Lightly and evenly grease the stopper for chamber D and place in position. Fill the connecting arm and bulb C_1 of the pipet to the mark at its top with the contained solution and close stopcock S_3. Close stopcock S_2 after rotating it once, then remove the stopper from D and blow compressed air into it to sweep out any chlorine. Dip the specimen in distilled water, remove, and press it between blotters until a quick weighing indicates that the specimen weighs 1.8 ± 0.1 times its moisture-free weight (4%–47% of moisture). With clean fingers, crumple the specimen together to crease it, open and tear into four or more pieces or sectors; then losely roll the pieces into separate cylinders or cones. Gently insert all the pieces of the specimen in chamber D, then replace the greased stopper in D and turn to ensure a firm seating. If desired, this stopper may be held in place by tying it with a string, or by using a special stopper clamp.

Fill buret A from bottle B, then open cock S_1 from the chlorine supply to buret A and fill it partially, by passing gas slowly from the cylinder. Discharge the buret completely through S_1 to remove the air, then refill it for the test, and close the cylinder valve. Turn cock S_1 through 90° to isolate the chlorine in A and open the chlorine supply line to the vent in case the cylinder valve leaks. Turn S_1 so that the three ways to it are open and, with the leveling bottle B, adjust the volume of gas in A to the mark. Then turn S_1 to close the buret A from the cylinder and vent.

Note: It is advisable, and very convenient, to have just enough solution in B so that when B rests on its support, the common level of the solution is at the zero mark in A. Check, and if necessary adjust, this level at least at the beginning and end of each series of tests, taking care not to trap an air bubble in the neoprene tubing.

Open stopcock S_3, then S_2 and start the timer. Firmly seat the stopper in D with the thumb and forefinger of one hand while quickly raising the leveling bottle B with the other so as to introduce the chlorine into D and thence to pipet C which forms a seal. The leveling of the liquid in C_1 and C_2 should be completed in 30 ± 10 sec. Thereafter, during the reaction period, continually adjust the height of the bottle B so as to keep the levels in both the arms of C the same. At the end of exactly 15 min., lower bottle B until the solution in the pipet reaches the mark at the top of C_1. Closes S_3 and measure the volume of chlorine consumed with buret A after adjusting its pressure to be atmospheric by means of bottle B. Check the stopper in D for its proper seating, note the temperature, and read the atmospheric pressure from a barometer.

Close stopcock S_2. Turn cock S_1 to connect buret A to the vent and raise bottle B so as to drive the residual gas from A. Remove the stopper and lift out the chlorinated specimen from D with forceps, then blow in compressed air to sweep away the chlorine. Wipe the inside of chamber D to remove any adhering pulp fibers and clean and regrease its stopper. The apparatus is now ready for the next determination.

Note: Constant temperature is not assured by working the apparatus at the ambient temperature; the 25°C. water should be continuously circulated through the jackets during the test.

Before recording results, open out the pieces of the chlorinated specimens and, after a few minutes, examine them for patches or spots which would indicate uneven chlorination. If any are evident, repeat the test, taking care to pack the pieces in the reaction chamber D more loosely.

Make a blank determination, by exactly the same procedure but, in place of the specimen, use an equivalent amount of quantitive grade filter paper wetted to contain approximately the same percentage of of water as the specimen.

Calculate the chlorine number as grams of chlorine consumed in 15 min. at 25°C. by 100 g. of moisture-free pulp, as follows:

$$\text{Chlorine number} = \frac{0.000423\,(V - b)h}{g\,(1 + 0.00366\,t)}$$

where:

V = volume of chlorine consumed by the pulp, ml.
b = volume of chlorine consumed in the blank determination, ml.
t = temperature in °C.
g = grams moisture-free pulp
h = barometric pressure, mm. Hg.

REPORT

Report the Chlorine Number as grams of chlorine consumed per 100 grams of moisture-free pulp, to the nearest 0.1%.

PRECISION

Duplicate tests on a single pulp sample are expected to agree within 5% of each other.

ADDITIONAL INFORMATION

This revision of T 202 m-45 is extensive. The following are the main changes:

(a) The previous procedure called for steaming the 2.0 g. specimen until 2.5 g. of moisture had been added and then standing overnight. The present modification has been found to give reproducible results with considerably less effort.

(b) The reaction chamber was larger than the gas buret. This made it impossible to surround the specimen with an atmosphere of pure chlorine. Now the buret has considerably more capacity than the reaction chamber and the heavier chlorine gas displaces the air upwards through the chamber D and leaves relatively pure chlorine.

(c) The 25°C. reaction temperature now specified permits easier and better control.

(d) A solution nearly saturated with $CaCl_2$ has been found to be more stable when saturated with chlorine than the 30 g. per 100 ml. solution specified previously.

(e) By varying the weight of the specimen with its chlorine consumption, the range of the test is extended and greater accuracy is obtainable; particularly with pulps having a low chlorine consumption.

(f) The factor of 0.000423 is now used instead of 0.000416. Chlorine weighs 3.2140 g.p.l. at S. T. P. so that the factor is:

$$3.214 \times \frac{100}{1000} \div 760 = 0.000423$$

LITERATURE CITED

1. Roe, Ralph B., *Paper Trade J.* 79, No. 15: 43–46 (Oct. 9, 1924) *Ind. Eng. Chem.* 16 No. 8: 808–811 (Aug., 1924).
2. Johannson, David, *Paper Trade J.* 101, No. 13: 101–104 (Sept. 26, 1935); *Tech. Assoc. Papers* 19: 431–434 (1936).
3. Mitchell, Claude R., "A Study of the Roe Chlorine Number," *Pulp and Paper Research Institute of Canada,* Tech. Report No. 69, (Jan., 1958).

REFERENCES

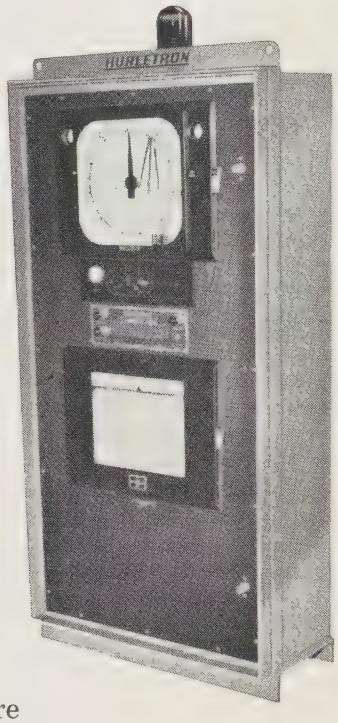
Genberg, G. P. and Johnsson, T., "Roe's Chlorine Number and Relation to Percentage Lignin Determined by a Modified Halse Method," *Paper Trade J.* 82, No. 22: 50–52 (June 3, 1926).

Beasley, W. B., Herbst, J. H. E., and Histed, J. A., "An Improved Method for the Determination of the Roe Chlorine Number," *Pulp Paper Mag. Can.* 58, No. 9: 133–136 (Aug., 1957), C. P. P. A. *Tech. Sect. Proc.* 1958: 371–374.

Eleventh
Testing Conference of the
Technical Association of the
Pulp and Paper Industry

Pantlind Hotel
Grand Rapids, Mich.
Sept. 27–29, 1960

CONTROLS MOISTURE AUTOMATICALLY!
That's why...
HURLETRON
Helps Produce BETTER PAPER



Hurletron's new moisture control measures, indicates and records moisture in the sheet to an accuracy of plus or minus 1/10 of 1%, and controls moisture content to 1/4 of 1% or less. That kind of control now makes it possible to raise moisture content to the top limit permitted by paper grade specifications. Moisture content in the finished sheet has been raised by at least 1% on most Hurletron-equipped machines.

In paper mills across the country, Hurletron is increasing paper quality and uniformity... increasing production by using less pulp content per ton... and increasing earnings. Write today for information about Hurletron's Complete Package Plan, including training and refresher courses for your operating and maintenance personnel.

ELECTRIC EYE EQUIPMENT COMPANY
DANVILLE, ILLINOIS

ROUTINE CONTROL METHODS

RC 281. Rapid Identification of Wet-Strength Resins

The object of this method is to identify the wet-strength resins used in a given sample of paper, by simple colorimetric methods.

Reagents

1. Phenylhydrazine hydrochloride, 1.34 g. (or 1.0 g. phenylhydrazine) in 41.7 g. concd. sulfuric acid which has been diluted to 80 g. Dilute solution to 100 ml.
2. Anhydrous ferric chloride, 10 g. in water to make 100-g. solution.

Procedure

Apply a drop of solution no. 1 to the paper to be tested. After absorption, apply a drop of solution no. 2 to the same spot. Observe the color change.

Results

Rapid red development indicates urea formaldehyde resin. Slow red development indicates melamine formaldehyde resin. No red development indicates absence of resin.

Notes

1. The test is based on formaldehyde so casein and glue sized papers containing formaldehyde give positive tests.
2. The test shows negative results on the alkaline curing wet strength agents presently on the market.

Submitted by E. N. Poor, Hudson Pulp & Paper, Augusta, Me.

This is a Routine Control Method and should not be considered as a Standard in any way. Corrections may be made before loose-leaf publication. Comments will be welcomed and should be sent to A. J. Winchester, TAPPI, 360 Lexington Ave., New York 17, N. Y.

RC-282. Repulpability of Splices

This test permits the study of repulpability of splices in water and in dilute caustic soda solution.

Apparatus

1. Waring Blendor
2. Blotting paper
3. Splicing tape
4. Sheet mold
5. Small Lightnin' mixer

Procedure

A. This test permits the study of repulpability of splices in water. The test duplicates the results obtained when splices are added to the beater for reprocessing.

A sandwich splice, made by placing an 8 by 1-in. strip of the splicing tape between two 8 by 1-in. strips of blotter paper, is cut into $^1/_2$-in. squares. To these squares, sufficient blotter paper cut into $^1/_2$-in. squares is added to make a total of 15 g. These squares are placed in a Waring Blendor with 500 ml. of water. The blendor is run for 30 sec. The stock which splatters up the sides and on the cover is washed back into the mixer with a wash bottle. Thorough washing is extremely important. The blendor is again run for 30 sec. and washed as before. After the washing, the Blendor is again turned on for a final 30 sec. This 90-sec. blend time insures a uniform stock, since all the squares have been subjected to repulping due to the washing and blending cycles.

The stock is then removed from the Blendor, rinsed twice with water, and made into a handsheet on a large sheet mold. The sheet is couched off the mold and pressed for one-half minute in a hydraulic press.

The sheet is removed from the blotters and dried. When the sheet is dry it is examined for particles of unrepulped splicing tape.

B. This test permits the study of repulpability of splices in a hot water solution of the chemicals used in the deinking process. This procedure differs from commercial processes in that the consistency is lower than usually run, and the agitation is much less intense. These deviations have been established so that observations can be made on the progress of the dispersion.

A 15-g. sample sandwich is prepared as in Method A above. The squares are placed in a 400-ml. beaker and 200 ml. of the cooking solution used in the mill deinking process added with the same percentages of chemicals as used in the mill. The squares should be stirred in the cold solution and observed for wetability. The beaker is then placed on a preheated hot plate, clamped in place, and a Lightnin' mixer lowered so that the propeller is about $^1/_2$-in. above the bottom of the beaker. The mixer is started and adjusted to give the sample a gentle rolling action. This treatment should be continued for one-half hour maximum after the temperature of the mass has reached 180 to 190°F. During this period, frequent observations should be made to determine whether any scums or foams develop and their persistence or nonpersistence, the speed with which the paper disintegrates, and any other factors which will yield useful information as to how the material might work in a commercial process.

At the end of the cooking period the stock is removed from the hotplate and made into a handsheet. The sheet is removed and treated as before. The dried sheet is examined for unrepulped splicing tape.

This is a Routine Control Method and should not be considered as a Standard in any way. Corrections may be made before loose-leaf publication. Comments will be welcomed and should be sent to A. J. Winchester, TAPPI, 360 Lexington Ave., New York 17, N. Y.

Binders for RC Methods

The Routine Control Methods Committee of the Testing Division has sponsored the idea of a loose-leaf binder to contain all the Routine Control Methods. The binder will be similar to that used for the Data Sheets, with three rings and suitably imprinted. The binder will be sold at cost. Orders should be addressed to TAPPI, 360 Lexington Ave., New York 17, N. Y., and accompanied by check or money order. The price of the binder is $1.50 per copy, postpaid.

Roll Storage Capacities and Floor Loading

TAPPI Data Sheet 203

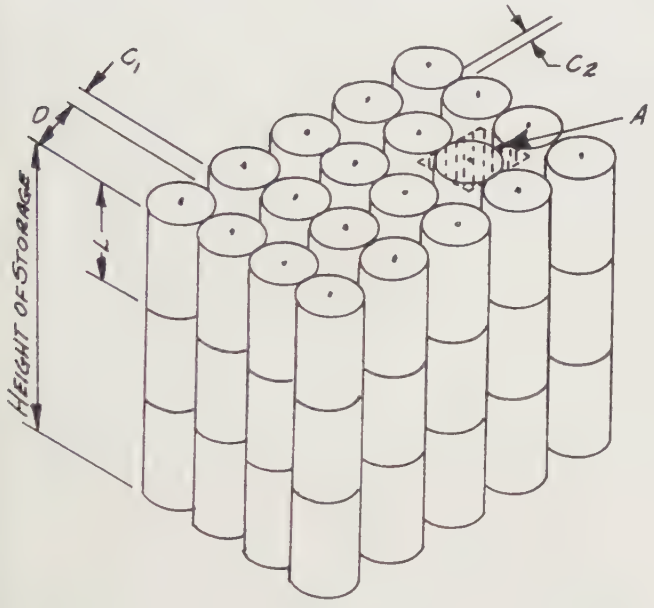
(THIS DATA SHEET IS UNDER THE JURISDICTION OF INDUSTRIAL ENGINEERING AND MATERIAL HANDLING COMMITTEE)

Section I Rolls stored vertically in lines with clearance between each line of rolls and with clearance between each vertical stack of rolls.

Section II Rolls stored vertically in lines with clearance between each line of rolls and without clearance between each vertical stack of rolls.

Section III Rolls stored vertically in a nested pattern without clearances.

SECTION I



Legend:
D = diameter of finished roll, inches
L = length of finished roll, inches
C_1 = clearance between rows, inches
C_2 = clearance between rolls, inches
W = weight of finished roll, pounds
$A = \dfrac{(D + C_1)(D + C_2)}{144}$
= square feet of floor area required to hold 1 roll weighing $W/2000$ tons for rolls piled one high on end.
N = number of rolls stored on end in each stack

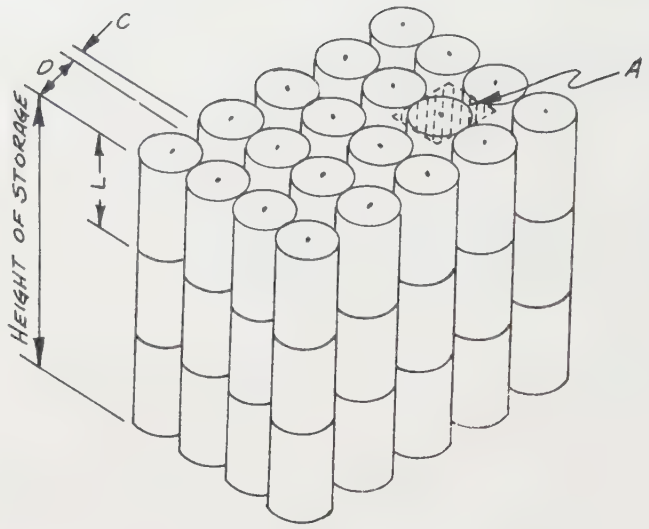
$$\text{Square feet of floor area required per ton} = \frac{A}{\frac{NW}{2000}} = \frac{2000(D + C_1)(D + C_2)}{144(N)(W)}$$

$$\text{Tons storage capacity per square foot of floor area} = \frac{NW}{2000/A} = \frac{144(N)(W)}{(2000)(D + C_1)(D + C_2)}$$

Height of Storage	*Height of rolls in storage*	*Floor space required per ton, sq. ft.*	*Storage capacity per square foot of floor space, tons*
1 roll high	$\frac{L}{12}$	$\frac{(13.89)(D + C_1)(D + C_2)}{W}$	$\frac{W}{13.89(D + C_1)(D + C_2)}$
2 rolls high	$\frac{L}{6}$	$\frac{(6.94)(D + C_1)(D + C_2)}{W}$	$\frac{W}{6.94(D + C_1)(D + C_2)}$
3 rolls high	$\frac{L}{4}$	$\frac{(4.63)(D + C_1)(D + C_2)}{W}$	$\frac{W}{4.63(D + C_1)(D + C_2)}$
4 rolls high	$\frac{L}{3}$	$\frac{(3.47)(D + C_1)(D + C_2)}{W}$	$\frac{W}{3.47(D + C_1)(D + C_2)}$
5 rolls high	$\frac{5L}{12}$	$\frac{(2.78)(D + C_1)(D + C_2)}{W}$	$\frac{W}{2.78(D + C_1)(D + C_2)}$

Note: The above data are based on the theoretical maximum storage. Due allowance must be made when using these data for aisles, planking, chocks, etc.

SECTION II



Legend:
D = diameter of finished roll, inches
L = length of finished roll, inches
C = clearance between rows, inches
W = weight of finished roll, pounds
$A = \dfrac{D(D + C)}{144}$
= square feet of floor area required to hold one roll weighing $W/2000$ tons for rolls piled one high on end.
N = number of rolls stored on end in each stack

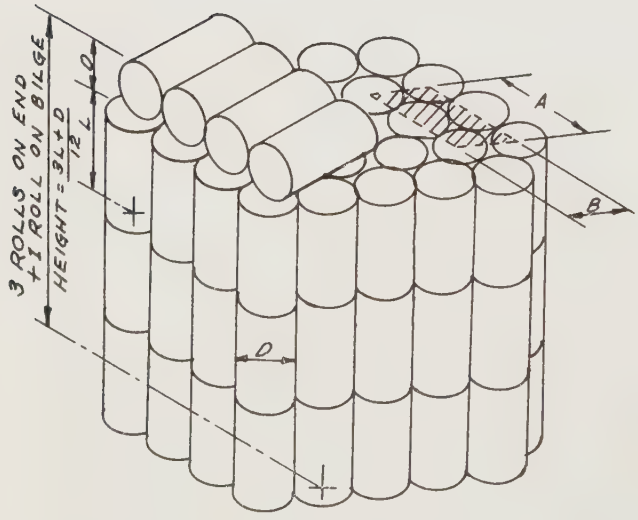
$$\text{Square feet of floor area required per ton} = \frac{A}{NW/2000} = \frac{(2000)(D)(D + C)}{(144)(N)(W)}$$

$$\text{Tons storage capacity per square foot of floor area} = \frac{NW}{2000/A} = \frac{(144)(N)(W)}{2000(D)(D + C)}$$

Height of storage	*Height of rolls in storage*	*Floor space required per ton, sq. ft.*	*Storage capacity per square foot of floor space, tons*
1 roll high	$\frac{L}{12}$	$\frac{(13.89)(D)(D + C)}{(W)}$	$\frac{(W)}{13.89(D)(D + C)}$
2 rolls high	$\frac{L}{6}$	$\frac{(6.94)(D)(D + C)}{(W)}$	$\frac{(W)}{6.94(D)(D + C)}$
3 rolls high	$\frac{L}{4}$	$\frac{(4.63)(D)(D + C)}{(W)}$	$\frac{(W)}{4.63(D)(D + C)}$
4 rolls high	$\frac{L}{3}$	$\frac{(3.47)(D)(D + C)}{(W)}$	$\frac{(W)}{3.47(D)(D + C)}$
5 rolls high	$\frac{5L}{12}$	$\frac{(2.78)(D)(D + C)}{(W)}$	$\frac{(W)}{2.78(D)(D + C)}$

Note: The above data are based on the theoretical maximum storage. Due allowance must be made when using these data for aisles, planking, chocks, etc.

SECTION III



Legend:
D = diameter of finished roll, inches
L = length of finished roll, inches
W = weight of finished roll, pounds
$A = 2D$
$B = D \cos 30° = 0.87D$
Floor area AB = $1.73D^2/144$, sq. ft. and holds 2 rolls weighing $W/1000$ tons for rolls piled one high on end

For rolls on bilge, weight = $W/2000$ tons. Tons occupies area = $DL/144$ sq. ft.
Whence weight on floor area of $1.73D^2/144$ sq. ft. will be $0.87DW/1000L$ tons

Method of storage	*Height of rolls in storage*	*Floor space required per ton, sq. ft.*	*Storage capacity per square foot of floor space, tons*
1 roll high on end	$\frac{L}{12}$	$\frac{12D^2}{W}$	$\frac{W}{12D^2}$
2 rolls high on end	$\frac{L}{6}$	$\frac{6D^2}{W}$	$\frac{W}{6D^2}$
3 rolls high on end	$\frac{L}{4}$	$\frac{4D^2}{W}$	$\frac{W}{4D^2}$
4 rolls high on end	$\frac{L}{3}$	$\frac{3D^2}{W}$	$\frac{W}{3D^2}$
1 roll deep on bilge	$\frac{D}{12}$	$\frac{14DL}{W}$	$\frac{W}{14DL}$
1 roll high on end + 1 roll deep on bilge	$\frac{L + D}{12}$	$\frac{12D^2L}{W(0.87D + L)}$	$\frac{(0.87D + L)W}{12D^2L}$
2 rolls high on end + 1 roll deep on bilge	$\frac{2L + D}{12}$	$\frac{6D^2L}{W(0.43D + L)}$	$\frac{(0.43D + L)W}{6D^2L}$
3 rolls high on end + 1 roll deep on bilge	$\frac{3L + D}{12}$	$\frac{4D^2L}{W(0.29D + L)}$	$\frac{(0.29D + L)W}{4D^2L}$
4 rolls high on end + 1 roll deep on bilge	$\frac{4L + D}{12}$	$\frac{3D^2L}{W(0.22D + L)}$	$\frac{(0.22D + L)W}{3D^2L}$

Note: The above data are based on the theoretical maximum storage. Due allowance must be made when using these data for loose storage, aisles, planking, etc. This sheet (Section III only) reprinted with permission of Engineering Data Sheet Committee, Technical Section, Canadian Pulp & Paper Association.

Flow Process Symbols

TAPPI Data Sheet

(THIS DATA SHEET IS UNDER THE JURISDICTION OF INDUSTRIAL ENGINEERING AND MATERIALS HANDLING COMMITTEE)

DEFINITIONS

1. Operation Process Chart: An operation process chart is a graphic representation of the points at which materials are introduced into the process and of the sequence of inspections and all operations except material handling. It includes information on time and location.

2. Flow Process Chart: A flow process chart is a graphic representation of the sequence of all operations, transportations, delays, and storages occurring during a process or procedure, and includes information on time and distance moved.

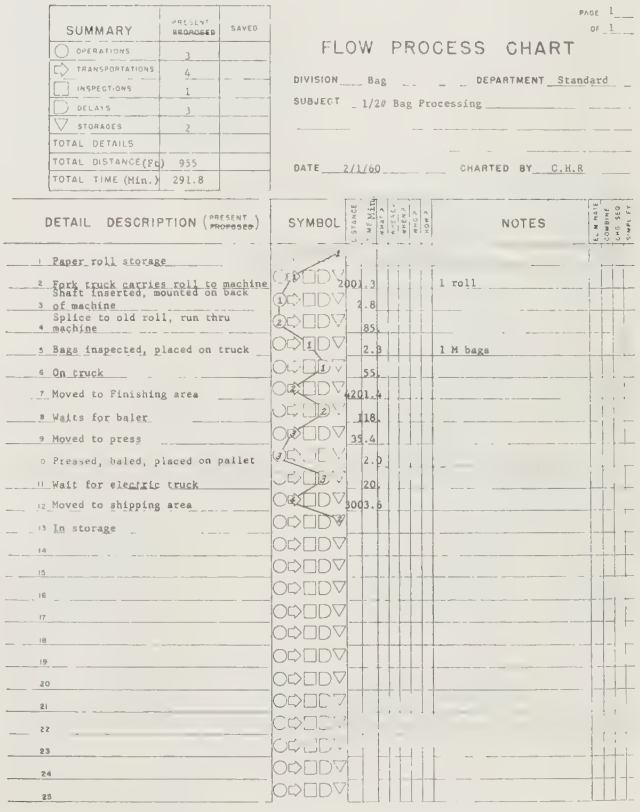
(a) The *material* type presents the process in terms of the events which occur to the material.

(b) The *man* presents the process in terms of the activities of the man.

ACTIVITIES DEFINED

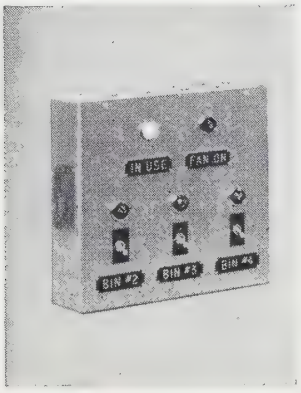
○ *Operation* occurs when an object is intentionally changed in any of its physical or chemical characteristics, is assembled or disassembled from another object, or is arranged or prepared for another operation, transportation, inspection, or storage. An operation may also occur when planning or calculation takes place.

Transportation occurs when an object is moved ⇨ from one place to another except when such movements are part of an operation or inspection.



Extracted from Operating and Flow Process Charts, 1947—with the permission of the publisher, the American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

RESULTING
HIGHER PRICES
FOR
GRADED SCRAP
CAN ACTUALLY PAY
FOR YOUR
OBP SCRAP SYSTEM

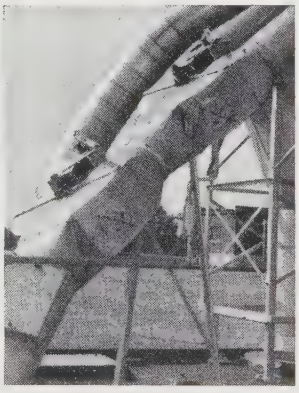


You can actually pay for an efficient, advanced OBP paper scrap system out of the increased prices obtained for properly graded paper scrap.

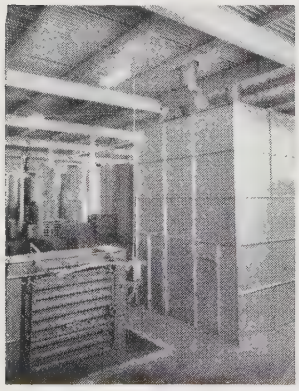
OBP is a leader in the development of pneumatic systems which will separate multiple grades of paper trimming and scrap . . . and you also get a clean plant, better working conditions, reduced fire hazard, improved working relations, and complete elimination of the cost and confusion of manual scrap handling.

Push button control can be furnished for automatic grade separation at each pick up point.

Special, electrically operated valves permit different grades of scrap to be economically conveyed through the same pneumatic line up to the point of actual storing or baling.



In two-grade system at Ottawa River Paper Co., scrap is graded through special control valve on main storage bin. Paper is then easily baled by grade for premium price.



Call today and request an OBP engineer to survey your plant and discuss your requirements. You may be amazed at the cost savings that a critical analysis can find.

We handle the complete job.

ENGINEERING
MANUFACTURING
INSTALLING

OHIO
BLOW PIPE COMPANY

1728 DOAN AVENUE
CLEVELAND 21, OHIO

- *Inspection* occurs when an object is examined for identification or is verified for quality or quantity.
- *Delay* occurs to an object when conditions do not permit or require immediate performance of the next planned action.
- *Storage* occurs when an object is kept and protected against unauthorized removal.
- *Combined Activity*—When it is desired to show activities performed either concurrently or by the same operator at the same work station, the symbols for those activities are combined.

DISCUSSION OF FLOW PROCESS CHARTS

Flow process charts contain operations, inspections, transportations, delays, storages, and any combinations of these in the order which they occur, connected by a line to indicate the direction of flow. Prepared forms with headings for distance, time, chart symbols, and process descriptions may be used but are not necessary. Present and proposed methods and a summary of results and expected savings may also be shown.

When material is followed from the beginning to the end of a process, the unit being charted may change from time to time. When this occurs, it is important to show what the unit is at any point on the chart so that confusion will be avoided.

Material-Type Flow Process Chart

		Feet	Minutes
1 mill roll	Stored in roll storage	. . .	. . .
	Moved to no. 2401 by FLT	280	4.22
1 M bags	Waited for operation to begin	. . .	128.40
	Print, cut, inspect, stack bags in truck	. . .	0.75
	Moved to baling area	500	15.61
	Waited for baler	. . .	218.90

It is preferable to use the passive voice in descriptions where material is being followed, except when this would conflict with terminology on shop records, like "print, cut, inspect."

When writing the descriptions of events on a man type flow process chart, the active voice is used because the man who is being followed is the one who initiates the action. On this type of chart, there are no horizontal lines representing the entrance of materials into a process, and the storage symbol is not used.

Man-Type Flow Process Chart

		Feet	Minutes
1 truck	Walk to truck	25	0.09
	Move truck to baler	25	0.24
	Press and bale 100 bags	. .	0.52
	Wait for electric truck	. .	0.28
	Press and bale 100 bags, stack on pallet	. .	0.63

LOCAL SECTION ACTIVITIES

Meeting Calendar

September, 1960

12 Eastern District, New England Section, Armand's Beacon Terrace, Framingham, Mass.

15 St. Louis Section, Le Chateau Restaurant, 10405 Clayton Rd., St. Louis County, Mo., "Paper Coatings Based on Cellulose Derivatives and Parlon Film Formers on Paper."

October, 1960

7–8 New England Section, joint meeting with Connecticut Valley PIMA, Schine Inn, Chicopee, Mass.

November, 1960

14 Eastern District, New England Section, Armand's Beacon Terrace, Framingham, Mass.

16 Pacific Section, Salem, Ore., "Modernization."

17 St. Louis Section, Le Chateau Restaurant, 10405 Clayton Rd., St. Louis County, Mo., "Recent Advances in the Packaging Field," by C. P. Olstad, Crown Zellerbach Corp.

December, 1960

5 New England Section, Storrowton Tavern, West Springfield, Mass.

January, 1961

9 Eastern District, New England Section, Armand's Beacon Terrace, Framingham, Mass.

March, 1961

13 Eastern District, New England Section, Armand's Beacon Terrace, Framingham, Mass.

April, 1961

10 New England Section, Storrowton Tavern, West Springfield, Mass., Management Night.

June, 1961

8–10 Joint Meeting, New England Section and Maine-New Hampshire Section, Wentworth-by-the-Sea, N. H.

Italian

Report of the Chairman, Piero Bersano

The year 1959 was full of events and activity, the most important of which was the official acknowledgment, by the Executive Central Committee of TAPPI, of the Italian local section.

I am convinced that what has been done is really useful, as a world organization grouping all the paper technicians can only be of great advantage to everybody.

In strict compliance with our purpose, such as it is clearly stated in the Articles of our Association, we have aimed at spreading widely our knowledge in the paper field, as well as the enrichment and improvement of the whole patrimony of knowledge and the discussion of technical problems.

What we have done, or have attempted to do, is well known to everybody; I think however that it will be advisable briefly to summarize the work we have actually done.

Eighty members attended the meeting on Testing Methods which took place at Stresa on April 9, 1959. The discussions which occurred at such meeting have been really useful and have led to the formation of two committees, namely the Committee for Testing Methods, and the one for Pulping, which both have displayed an outstanding activity during the whole year.

Also the Groundwood Committee has continued the work started last year after the meeting at Vicenza, and the results will be illustrated later on, in the course of this meeting.

Of course, the work of these committees cannot certainly be considered as achieved, as new ideas and proposals will be put forward to be discussed by us all at the next meetings.

We have unfortunately no sufficient time today to discuss exhaustively all the subjects. However, we expect to organize further meetings in the next few months at which each member will be able to show his own views, and we shall try to come to conclusions representing the positive corollary of detailed exchanges of opinions among experts in this field.

Twenty-eight members took part, in May last, in the visiting tour we had organized to North American mills, and I feel that all the members who participated in these visits have certainly appreciated our initiative which enabled us to notice the really tremendous effort that both the world paper industry and the North American one in particular are making in the paper field.

About 40 members attended a meeting which was held at Bari on Sept. 10, 1959, to examine the actual possibilities in the sphere of the European Market and of the wider World Market.

This meeting was realized in cooperation with the Italian Center for the European common market and, in my opinion, is resulted in a full success for our Association, as on that occasion we laid the first stone of our future basic activity, aiming at finding out the means which may allow the Italian paper industry to survive and start a period of prosperity after overcoming the present critical period.

Coming now to the publications, you know well that our bulletin, inserted in the *Industria della Carta* magazine, is being sent to all our Italian members.

We would also have the possibility of sending another magazine to our members but in this particular connection I would only mention this fact as a mere future possibility, since I have not yet informed our officers.

Twelve TAPPI Standards, already translated, have also been distributed, and further ones will follow, as the Committee for Testing Methods is able to have the relative translations printed; this work, undertaken by the Committee for Testing Methods is being developed in a really careful and attentive way.

Recently we sent to our members the volume on the Acta of Bari meeting which, as I have stated above, should mark the beginning of a considerable activity.

I would therefore invite you to read it, and I also wish to apologize for the failures you will perhaps find in it, due to the fact that we were unfortunately obliged to proceed very quickly, in consideration of the vast extent of the subject which was dealt with.

Please consider this volume attentively and try to spread it; should then anybody, outside our Association, be interested in it, you may ask for it, thus seeing to it that this problem may be discussed as widely as possible.

Attending the Italian Section meeting at the Villa d'Este, Como, are, from left to right: W. C. Bloomquist, of the TAPPI Executive Committee; Senatore Luigi Angelo Bonomelli, Assessore Administrazione Provinciale di Como; S.E. Dr. Giacinto Guida, Prefect of the Como Province; Dr. Piero Bersano, chairman of the Italian Section and Technical Director of Cartiere Burgo; Ronald G. Macdonald, Treasurer of TAPPI; R. G. Moffly, USA Consul in Turin; On. Comm. Eugenio Rosasco, President of the Chamber of Commerce, Como; Dr. Emilio Sancassani, President of the Unione Industriali, Como

The Italian translation of the TAPPI Monograph: "Paper Loading Materials" was issued in January last and was sent to all our members free of charge.

Here is, therefore, all what we managed to do in the field of publications: even if it does not appear to be relevant, it is nevertheless considerable work when considering that it was done by detracting work hours from our normal activity.

You will perhaps object that we have done little. Unfortunately we have done only what the actual situation allowed us to do. We would have liked to do more, but we had to face some difficulties coming from the availability both of people and money.

Anyhow I can plainly tell you that nothing has been neglected to the advantage of our Association and, in telling you so, I wish to express a special acknowledgment and deep thanks to our friends of the Executive Committee, Mr. Bosso, Mr. Cirla, Mr. Ghisoni, Mr. Gregotti, Mr. Marsoni, Mr. Nodari, Mr. Restagno, Mr. Ruspa, and Mr. Villa.

Our committee is not one of the usual formal bureaucratic organizations, but it is an assembly of friends who all felt the necessity to do something for the Italian paper industry, which is our own industry.

If we have been great in past times, we have now decayed and we should decay more and more if we cannot manage to gather our strength. Our problems are somewhat different from other people's, and it is only with the unity of our efforts that we will be able to reach a solution. I feel quite sure that good results can be attained if everybody gives his cooperation.

R. G. Macdonald addressing the Italian Section of TAPPI at the Villa d'Este, Como

This first experimental year of our local section has clearly revealed your firm good will to act well to the advantage of the Italian industry. The increase in the number of members shown by the statistical data emphasizes the actual interest toward our Association, but it will remain but a mere figure if it is not vivified by enthusiasm.

If our good will does not fail, and our work is complied with the agreeing effort of everybody, all difficulties will disappear.

We shall also be able, in particular, to overcome the financial difficulties, enabling in this way the industry to ascertain the seriousness of our purposes and the usefulness of our meetings. This will certainly lead to more generous helps coming from the industry and—I should say—to the practical realization of the saying: "God helps him who helps himself."

I close my speech wishing our successors to lead our Italian Section to a greater and greater activity in future.

A. Restagno, *Secretary*

St. Louis

James Lyon, chairman of the St. Louis District of the Technical Association of the Pulp and Paper Industry, announces that on April 28, the organization was chartered as an independent section of National TAPPI.

Jim Lientz, president of TAPPI, presenting Section Charter to James R. Lyon, retiring chairman of St. Louis District

J. R. Lyon, retiring chairman presenting gavel to new chairman, W. J. Rice

J. R. Lientz, National President, presented the charter at the district's regular meeting at Le Chateau Restaurant, 10405 Clayton Road, St. Louis. The St. Louis District of TAPPI was founded in 1957 and has been operating as a branch of the Chicago TAPPI Section. Growth of member-

Newly elected St. Louis Section officers, Left to right: J. J. Koenig, past chairman, W. J. Rice, chairman, M. J. Moriarity, vice-chairman, B. L. Scallet, secretary-treasurer, V. C. Gramsch, member-at-large, C. P. Olstad, member-at-large

ship and activities of the St. Louis group warranted the district being established as an independent section.

Featured speaker of the evening was J. F. Butterworth of Socony Mobil Oil Co., whose topic was "Waxes and Their Uses in the Paper and Packaging Industry." Following was the installation of officers for 1960–61 term of office. The group's new officers are W. J. Rice, chairman, M. J. Moriarity, vice-chairman, B. L. Scallet, secretary-treasurer, V. C. Gramsch, member-at-large.

Ohio

The pulp and paper technology courses developed at Miami University through industry's support represents a talent recruitment policy which Ohio's papermakers should develop more fully, Howard E. Whitaker, board chairman of the Mead Corp., and new national president of the American Paper and Pulp Association, told Ohio TAPPI members at their April meeting.

The group had met on the Miami campus to inspect new laboratories set up by the university, with equipment contributed by the industry, to serve Miami's pulp and paper technology and chemistry program.

The program, now in its third year, was established with industry support after original proposals for a cooperative effort were made by Ohio TAPPI's education committee several years ago. Since much of the first two years of the curriculum follow Miami's common curriculum, the 1959–60 school year as the junior year of the program's first class had been designated as the year by which special laboratories for the program would be ready.

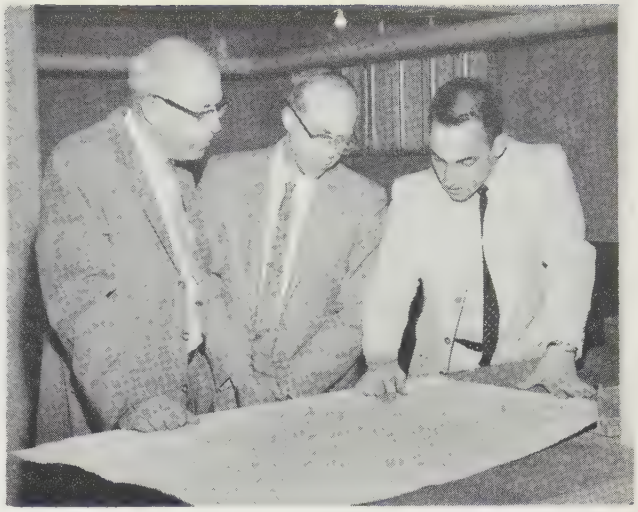
A three-story Miami building has been remodeled by the university and provided with laboratory equipment donated by firms in the industry.

Whitaker, as principal speaker at TAPPI's April meeting, pointed out that the Miami program "will continue to need money and other support, but primarily needs sustained interest to be successful."

"In these days, we find that much of the young talent we would like to have in the paper industry is attracted to the glamor industries such as electronics, aviation, atomic energy, steel, petroleum, and chemistry," Whitaker said.

"The paper industry needs to convince teachers, vocational advisors, parents, and the public in general that this industry is a fine place to work and its people fine people to work with.

"I'd like to suggest that there are several good reasons why the paper industry has been making such a slight impression on the public as a career opportunity. In the first place, paper is so universal that we are not considered a glamour industry. Second, paper people are clannish—they should mix with the engineers of other industries more. Third, our technicians are reluctant to recruit.



Left to right: Earl Zuehlke, hydraulic engineer, E. W. Sherron, manager of sales correspondance, both of Black-Clawson, Inc., Middletown, Ohio, and James R. Weber, Jr., from Brooksville, Ohio, a student in the Miami program

"We need to circulate, to widen our acquaintances, and to broaden our horizons."

Whitaker is chairman of the executive committee for the industry-wide advisory committee which has helped Miami shape its pulp and paper program. He pointed out that the advisory committee of 35 men is divided into six subcommittees concerned with equipment, the academic program, publicity, student personnel recruitment, work placement, and finance.

C. Edwin Brandon, former Howard Paper Co. technician, who is director of the Miami program, summarized the progress of the program.

"Our most urgent need at the moment is for faculty," he disclosed. "We are looking for at least one good experienced paper chemist and would be interested in talking to anyone you know who might be qualified and available." Brandon said equipment donated by the industry had been meeting current requirements, although more would be welcomed in the future; that the supply of students had been about as expected and that four separate programs have been worked out within the pulp and paper curriculum.

The Miami program this spring, Brandon said, includes 7 juniors, 5 sophomores, 15 freshman, one graduate student in chemistry who is taking pulp and paper courses and two others who are completing prerequisites to pick up the program next year.

Left to right: Tom Marianos, Virgil Hall, Jr., and John Watson, all of Wrenn Paper Co., Middletown, Ohio

South Eastern

The following papers were presented at the Southeastern Section of TAPPI in Columbia, S. C., March 25, 1960.

Use of Titanium Equipment in Chlorine Dioxide Bleaching

Henry B. Meier

The use of titanium in some bleaching equipment at Riegel Paper Corp., Acme, N. C., was not a coincidence. It was the result of extensive investigation by our engineering, production, and maintenance departments. I will endeavor to follow these developments at greater lengths after a brief look into the type mill and bleaching operation we have.

Our mill started operations in December of 1951 at a design rate of 200 tons per day of high quality bleached hardwood and softwood kraft market pulp. We had the most up-to-date chlorine dioxide bleaching process in the industry. As shown in Fig. 1 our bleach plant consisted of six stages; chlorine, caustic, hypo, caustic, hypo, and chlorine dioxide. Each of the stages after the initial chlorine treatment was preceded by a vacuum type washer and a steam mixer. In the chlorine dioxide sequence the steam mixer was followed by a thick stock pump, chlorine dioxide mixer, upflow pre-retention leg and the downflow chlorine dioxide tower.

As mentioned previously, Riegel Carolina was originally designed for 200 tons per day of bleached pulp. However, our customers and our own mills in New Jersey soon indicated their confidence in and enthusiasm for our quality product by increasing their orders. This resulted in a program of expansion which brought us to 500 plus tons per day of bleached pulp.

The increase to two and one half times the startup production rate from 1951 to 1956 resulted from considerable changes and additions to the entire pulp mill. We are particularly interested in those in the bleach plant. Here three stages were added, consisting of chlorine, caustic, and chlorine dioxide. Our bleach plant proper then became divided into one plant of six stages and one plant of three stages.

Simultaneously with, and as a result of the construction of the "Carolina Belle" paper machine, two additional stages were added to the bleach plant in 1956–57. These stages consisted of another hypo and another chlorine dioxide stage. After some juggling of towers and washers accomplished by considerable piping changes, the following arrangements were reached. The no. 1 bleach plant remained six stages; chlorine, caustic, hypo, chlorine dioxide, caustic, and chlorine dioxide. The no. 2 plant became a five-stage sequence of chlorine, caustic, hypo, chlorine dioxide, and chlorine dioxide. The considerable changes in the bleach plant and in the mill generally and the addition of the paper machine have resulted in production in excess of 700 tons per day of high quality bleached pulp and paper.

Facts about the bleach plant have been given to illustrate the variation in conditions that we have experienced. It should also be remembered that throughout this period we have continued to improve pulp quality with chlorine dioxide being used in the "workhorse" stages generally. The net result has been that both through-put and chemical usage in chlorine dioxide mixing equipment have increased. As a result of eight years' experience, we feel that we have faced most of the corrosion problems inherent in pulp bleaching with chlorine dioxide.

Our major corrosion problem has been with the unit used to mix the chlorine dioxide with the pulp. In Fig. 2 an enlarged view of the components in and around such a chlorine dioxide mixer can be seen.

The sequence of equipment of the chlorine dioxide stage starts with the preceding washer where all of the prior stage

Henry B. Meier, Riegel Paper Corp., Acme, N. C.

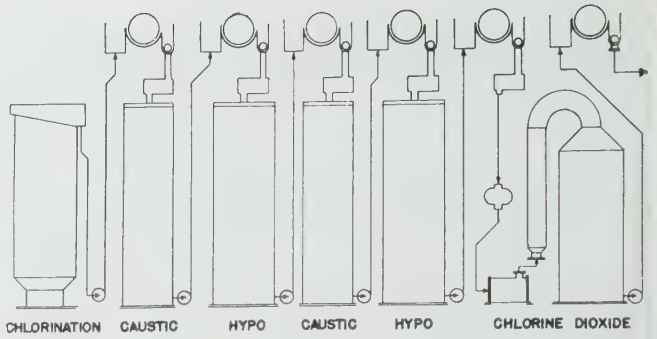


Fig. 1

chemicals are removed. The pulp leaves this washer at 12% consistency and proceeds through a steam mixer where 50-p.s.i. steam is added to bring the pulp to a temperature of 175°F. The heated pulp then drops by gravity flow to a thick stock pump which supplies, by positive displacement, the pressure necessary to impel the pulp through the succeeding tortuous routes. From the thick stock pump the pulp travels down and into the chlorine dioxide mixer at a pH of 8 to 8.5. Here chlorine dioxide is metered into the pulp and thoroughly mixed. After the mixer, the pulp proceeds uninterruptedly through the upflow pre-retention leg at a pH of about 5 and into the downflow tower. It naturally follows that the mixer itself is the center of the corrosion problem.

The original chlorine dioxide mixer purchased for the mill was a double shaft, vertical mixer with a brick lined mixing chamber. This mixer proved inadequate in design and capacity. Moreover, material of construction proved unsatisfactory. The pointing particularly was subject to deterioration requiring costly down time, material, and labor. This, coupled with the inability to handle any appreciable increase in tonnage rate, necessitated its replacement by the horizontal mixer shown in Fig. 3.

The first horizontal chlorine dioxide mixer purchased by Riegel was lined with a $^1/_8$-in. thick high nickel stainless steel alloy.* The inlet elbow and discharge piping of the mixer were also fabricated of this material.

As noted in Fig. 3, the mixer consisted of a 16-in. diameter inlet *A* mixing chamber *B*, single shaft rotor with mixing

* The per cent chemical composition in the high-nickel alloy material in wrought form is: cobalt, 2.5; chromium, 14.50–16.50; molybdenum, 15.00–17.00; tungsten, 3.00–4.50; iron, 4.00–7.00; silicon, 1.00; manganese, 1.00; carbon, 0.08; vanadium, 0.35; phosphorus, 0.04; sulfur, 0.03; and nickel, the balance; and in cast form is: cobalt, 2.50; chromium, 15.50–17.50; molybdenum, 16.00–18.00; tungsten, 3.75–5.25; iron, 4.00–7.00; silicon, 1.00; manganese, 1.00; carbon, 0.12; vanadium, 0.20–0.40; phosphorus, 0.04; sulfur, 0.03; nickel, the balance. It should be understood that this alloy has given excellent service in many bleach plant uses, and is used extensively by Riegel, particularly in the pulp chlorination system.

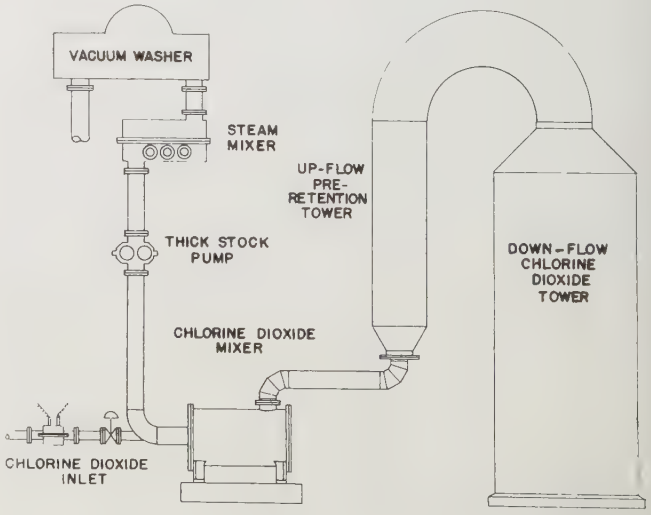


Fig. 2

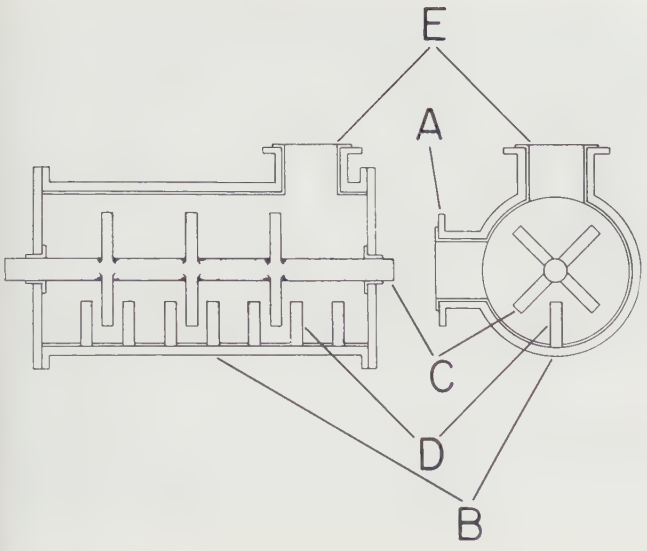


Fig. 3

pegs *C*, fixed mixing pegs *D* and 16-in. outlet *E*. This mixer is in our opinion superior to any we have encountered. This is evidenced by its ability to continue excellent mixing characteristics at almost double the rate for which it was purchased. Incidentally, Riegel personnel contributed significantly to the development of this mixer which I understand is in fairly common use in the industry.

This mixer had been in service approximately 12 months when a scheduled shutdown inspection revealed that considerable pitting and erosion was taking place. After a total of approximately 18 months, the high nickel alloy liner had deteriorated further. The deterioration was in the form of deep pitting and hairline cracks. General loss of thickness, particularly at the inlet end and opposite the rotor mixing pegs, was encountered. There was also erosion and pitting of the stationary mixing pegs and welds.

It was first decided to reline the mixer. It was found that this would require considerable down time of an absolutely essential piece of equipment.

A decision was then made to "patch up" the liner with builtup welds as much as possible and put it back in service until such time as a replacement could be purchased and installed. Our maintenance people had no easy time building up with welds the more critical areas; however, it was accomplished within the three-day shutdown. We were advised that this was a stop-gap measure and we should use all haste to get a replacement mixer.

A review of the brief history of the existing mixer convinced everyone that a repetition of this situation would be very undesirable. Shortly before this repair was made on the lined mixer, two new mixers of $^1/_2$-in. solid material of the same alloy were purchased for two additional chlorine dioxide stages; these had been installed and put into operation. Later inspection of these units indicated some small loss of thickness and minor etching. While there had been no general dissatisfaction with the results of the solid mixers at the time a decision had to be made on a replacement unit for the lined mixer, it was apparent that the alloy used was not perfect for the application; and it was felt that there must be a better material for use in these mixers.

Materials of various types were investigated and found to be in our estimation lacking in the important features of extreme corrosion and erosion resistance. There was one exception—titanium† appeared to have the qualities needed for this application. A brief look at these qualities will show the reasons this material was considered for a chlorine dioxide mixer liner.

† The material used in the mixer is A-70 commercially pure titanium.

Titanium is known to be a light, strong, corrosion resistant, and ductile metal. Prior to 1955 it was mostly associated with the aircraft and missile field; but after a price reduction of 50%, in 1954, it could compare favorably price wise with highly alloyed grades used for very severe corrosive applications. (It is said that new price reductions in 1959 add to its attractiveness.)

Titanium's availability in various forms is an important feature as it can be ordered in all standard mill shapes and in seamless and welded tubing. In importance, weldability is probably second only to corrosion and erosion resistance. Welding requires no unusual precautions. Fusion welding with inert gas shielded arc is used and the resulting weld offers excellent corrosion resistance just like the parent metal.

Titanium also offers excellent resistance to contact or crevice corrosion. This is an attack encountered around gasketed joints, corners, and overlaps, and had been encountered with the alloy liner. It is generally caused by oxygen-concentration cells that lead to severe pitting. Titanium is also remarkably free from fouling and it resists corrosion product buildup. The yield strength specifications of 70,000 to 95,000 p.s.i. for A-70 titanium and 55,000 to 80,000 p.s.i. for A-55 titanium permits the use of thinner gage material.

After correspondence with and visits from the titanium representatives, it was decided to try titanium sheets of $^1/_8$-in. thickness rolled as a liner into a cast steel mixing chamber. Also the stationary mixing pegs in the bottom of the chamber were to be titanium. The shaft and revolving pegs were to be of the previously used high nickel alloy, as these had given good service in the earlier mixer. Work was started immediately and in a matter of a few months the equipment supplier shipped the new titanium lined chlorine dioxide mixer. It was installed in December, 1955, and the other was relined and left as a spare.

All that was needed was final proof in operation. It is believed that Riegel has such proof as shown by the periodic inspections (an average of three each year) and an audigage, micrometer, and visual inspection by titanium fabricator and metal supplier technicians. In essence, it has been determined that there has been no significant change in thickness of the $^1/_8$-in. titanium liner and fixed mixing pegs. There was also little change in the titanium welds and they appeared in excellent condition. In many cases the oxide film which normally develops at the edge of weld shielding was still visible.

Fortunately, a direct comparison between the high nickel alloy mentioned throughout this paper and titanium was also available in this mixer inspection. The end coverings and the collar around the rotor directly adjacent to the titanium liner are of the high nickel alloy material. The inspection reports showed considerable etching, pitting, and small cracks in the nickel alloy material even though the adjacent titanium liner was unaffected.

The results of this and subsequent inspections have indicated that the cost of the titanium liner has been more than justified. The titanium lined mixer did cost slightly more than the $^1/_2$-in. solid high nickel alloy mixer. However, in our opinion a considerably longer life will be obtained from the titanium lined mixer. (The latest cost comparison shows the $^1/_8$-in. titanium lined mixer now costs less than the $^1/_2$-in. solid alloy mixer.)

The gratifying results obtained from the use of titanium as liner and peg material in the chlorine dioxide mixer proved very valuable in solving another of our severe corrosion problems.

This problem was encountered in the chlorine dioxide manufacturing plant. Our chlorine dioxide is generated in Solvay reactors of the general design shown in Fig. 4. Nozzles "A" and "B" are used for injecting the reactants and air, and these were originally made of polyvinyl chloride. The combining of 45% sodium chlorate solution, 60° Be. sulfuric acid and 100% methanol in the lead lined reactors was too corrosive for the polyvinyl chloride nozzles. They com-

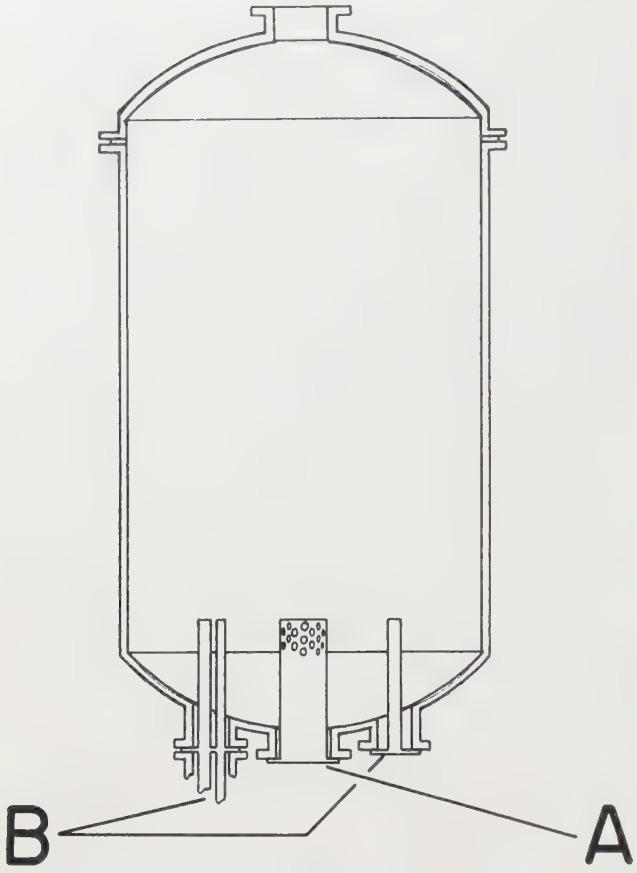


Fig. 4

pletely disappeared after only approximately one year of service. Although we have had very good experience with this material in many pulp mill uses, and it has replaced expensive alloys in a number of cases, it did seem that satisfactory service could not be obtained under these conditions. Since titanium had been used so successfully in the admission of chlorine dioxide into the bleaching system, then it was a natural choice for use in the reactors as shown in Fig. 4. This material was used to fabricate these nozzles and they were installed in a reactor. After one year of continuous use, the titanium nozzles‡ were found to be in excellent condition. This indicates a life infinitely greater than that of the original material used in this application and, as in the mixer liner, is more than justified from a cost standpoint.

In conclusion, I would like to point out that other uses for titanium in the manufacture and use of bleaching agents are being studied. This material has come a long way in a short time and I feel sure that we will see more uses of titanium for severely corrosive conditions in the pulp and paper industry.

Pacific

The twenty-second annual Shibley Award program of Pacific Section TAPPI was held at the Elks Club, Everett, Wash., March 15, 1960. This event, named in the memory of "Cap" Shibley, brings several young men in the industry to present papers of a technical nature based on some operation or investigation which they personally conducted in the course of their employment. Each is judged on the planning, organization, presentation, amount of individual work, and contribution to the technical knowledge of the industry and the contestant receiving the most number of points is awarded a check. The other contestants also receive a suitable token of their participation.

‡ The material used as nozzles in reactors is A-55 commercially pure titanium.

Dinner at the March meeting of the Pacific Section

The head table, left to right: Lloyd Boots, Simpson Paper Co.; William West, Crown Zellerbach Corp.; E. E. Egan, Crown Zellerbach Corp.; N. W. Coster, Scott Paper Co.; J. L. McCarthy, University of Washington; Norval Magnusson, Puget Sound Pulp & Timber Co.; Paul Billington, Weyerhaeuser Co.; John McEwen, Weyerhaeuser Co.; Robert Smythe, secretary-treasurer, Pacific Section; Sidney Silverstone, Scott Paper Co.

Left to Right: William West, Lloyd Boots, and E. E. Egan, Shibley Award contestants

Moderating the Shibley Award program this year was Paul S. Billington, Weyerhaeuser Co., Research Dept., Longview, Wash. Mr. Billington is the immediate past chairman of Pacific Section TAPPI. The papers presented were as follows:

1. "A Power Factor Study Using Existing Metering," by E. E. Egan, Crown Zellerbach Corp., Camas, Wash.
2. "The Development of a New Retention Aid," by Lloyd Boots, Simpson Paper Co., Everett, Wash.
3. "Improving Black Liquor Oxidation Efficiency of Packed Towers," by William West, Crown Zellerbach Central Research Department, Camas, Wash.

A social hour followed the presentation of the papers and dinner was served at 6:30 p.m. Highlighting the program was the announcement of the Shibley Award winner by Paul Billington who presented the award to William West.

J. L. McCarthy, Dean of Graduate School, University of Washington, was our honored after dinner speaker and presented a program augmented with color slides of his observations and travels through European University and pulp mills.

ROBERT SMYTHE, *Secretary-Treasurer*

Pacific TAPPI-CPPA

One of the most successful conventions in recent years resulted when Pacific Section TAPPI and Pacific Coast Branch, Technical Section, CPPA, held their annual meeting April 28–30, 1960 at Bellingham, Wash. The convention co-chairmen Norval Magnusson, Puget Sound Pulp & Timber Co and J. H. Shumka, MacMillan Bloedel, Powell River, Ltd., were hosts to some 340 enthusiastic mill and supply people in attendance. TAPPI's part of the program was chairmaned by P. T. Dickie, Crown Zellerbach Corp., West Linn, Ore. The Friday morning session included the following papers, presented by outstanding men in their field:

"Improvement in Utilization of the Complete Tree and Future Possibilities," J. B. Grantham, Chief, Division of Forest Utilization Research, Pacific Northwest Forest and Range Experiment Station, U. S. Forest Service, Portland, Ore.

"Improvements in Forestration," Carl Garey, Resident Forester, Weyhaeuser Co., Monroe.

"Utilization of Wood Residues," G. H. Chidester, Chief, Division of Pulp and Paper, U. S. Dept. of Agriculture, U. S. Forest Products Laboratory, Madison, Wis.

"Refiner Studies, Utilization of Pulping Rejects, High Yield Pulping," J. T. Henderson, Project Leader, Central Research Dept., Crown Zellerbach Corp., Camas, Wash.

"Utilizing Noncellulosic Materials from Pulping Process," Carter Watson, Technical Director, Puget Sound Pulp & Timber Co., Bellingham.

"The Chemical Industries' Contributions to Improved Utilization of Wood," D. V. Redfern, vice-president and general manager, American Marietta Co., Seattle.

The Saturday technical program was presented by CPPA and in the afternoon the two organizations conducted separate round-table sessions. "Machine Drying of Pulp," moderated by J. H. Bardsley, B. C. Forest Products, Ltd., Crofton, B. C., was the subject of the CPPA group and "Wet End Additives in Papermaking," moderated by C. W. Davidson, Crown Zellerbach Corp., Camas, Wash., was the topic of discussion by the TAPPI group. Serving on this panel were:

C. L. Ducharme, General Mills, Inc., Minneapolis, Minn. "Technical Aspects of Starch and Gum Wet End Additives."

William Linke, American Cyanamid, Stamford, Conn. "Technical Aspects of Wet End Additives."

Lloyd McDonald, Longview Fibre Co., Longview, Wash. "Discuss Operational Aspects of Wet End Additives."

J. T. Frawley, Hercules Powder Co., Wilmington, Del., "Discuss Effects of Food Additives Amendment on Pulp and Paper Industry Suppliers."

R. C. Mispley, Crown Zellerbach Corp., San Francisco, Calif., "Discuss Effects of Food Additives Amendment on Pulp and Paper Industry."

A very fine ladies' program enabled the ladies to choose from a number of activities such as golf, swimming, bridge tours, style shows, etc.

Dr. J. L. Keays, Research Director, MacMillan Bloedel, Powell River, Ltd., was the guest speaker at the men's luncheon Saturday and presented one of the most interesting and understanding glimpses of Russia as he viewed it during a recent visit there. Color slides showing the country and people gave additional insight into the problems of Russia.

The Annual business meeting of TAPPI Pacific Section was held Saturday. Two items of importance were acted on: one was the revision of our Bylaws and the second, the election of officers. Placed in nomination and elected by unanimous vote were:

P. T. Dickie, Crown Zellerbach Corp., *chairman*
Curtis Walseth, Weyerhaeuser Co., *vice-chairman*
R. H. Smythe, Ray Smythe Co., *secretary-treasurer*

Executive Committee:
Lyle Gordon, Scott Paper Co.
C. W. Davidson, Crown Zellerbach Corp.
Douglas Armstrong, R. T. Vanderbilt Co.

We were fortunate to have a representative of National TAPPI, Mr. H. O. Teeple, with us during the entire convention. Mr. Teeple brought with him the warm wishes of TAPPI and gave us valuable counsel.

Wrapping up the activities of the meeting was a large banquet at which the new officers were introduced and awards made. Dancing followed till after midnight when a splash party in the hotel swimming pool concluded the scheduled events. Meeting in 1961 will be three associations, the Supts., CPPA, and TAPPI. This Tri-Way meeting is scheduled for Harrison Hot Springs.

ROBERT SMYTHE, *Secretary-Treasurer*

Empire State (Eastern District)

The Eastern District of the Empire State Section of TAPPI held their February 18 meeting at the Queensbury Hotel, Glens Falls, N. Y. The dinner and program were attended by 114 members and guests. Membership in this district totals 167 at this time and a list of the names and addresses was sent out recently to the members.

The meeting was called to order by Chairman Paul Page at 8:00 p.m.

W. Montgomery reported that we have in the treasury $67.29 in the checking account and $527.60 in the reserve fund for a total of $594.89.

Plans for the Annual Ladies' Night on May 21 had not progressed sufficiently for any details to have been given at that time.

Mr. George E. Clink of the Sandy Hill Iron and Brass Works was introduced by Gordon Rabeler our Program Chairman. After Mr. Clink's talk on the Sandy Hill Rotoformer an interesting question-and-answer period followed, and the meeting was adjourned.

V. W. POTTS, *Secretary*

Empire State (Metropolitan District)

The following paper was presented at the meeting of the meeting of the Empire State (Metropolitan District) Section of TAPPI, April 12, 1960.

The Next Challenge—Impermeable Cartons

Robert J. Kelsey

IT IS a pleasure to share with you some of our observations on the exciting future for paper packaging. And we expect it to be exciting too. Because in spite of the rapid developments in polymer plastics, paper still remains the

ROBERT J. KELSEY, Engineering Editor, *Modern Packaging* Magazine.

favorite packaging material for uncounted thousands of products. With good reason. Not only are paper packages low in cost, but major developments in surface treating and printing during the past few years have also made them the brightest packages on the market from a merchandising standpoint.

However, the gage of how well you are holding your position in the packaging field, today, is the amount of research and imagination you direct at trying to get ahead. Every packaging industry needs exciting and dramatic developments to create interest and talk among packagers and a feeling that suppliers are dynamic in their approach to modern packaging problems. For papermen, we feel that creation of more effective barrier cartons would supply such an exciting spark.

It is also a necessary step. For I must tell you that the cartons and wraps that are used for sensitive food and chemical products today are now not good enough and must be improved. Here, is a challenging area for the application of research and imagination. And a dramatic way to improve this area of paperboard packaging is to not only produce a better and more economical container for the dry and frozen products that are now so cartoned, but to jump one step further to new folding carton constructions for liquids.

Before tackling this problem, though, let's first look at present paperboard containers used for cereals, cookies, crackers, candies, powdered desserts and many other foods. These have, generally, drawn their barrier properties from packaging components such as overwraps, inner wraps, separate inner bags, and so forth that are waxed or otherwise coated to give impermeability.

Now, as much as these extra packaging layers help to sell more paper, they have generally been applied in the packaging plant on additional machines. Packagers don't like these added steps. They require extra machinery and labor and are generally far slower than cartoning operations.

Also, food processors want more and more packaging speed to offset normal increases in the cost of labor and materials and the equipment for adding separate wraps, bags, or pouches has just not been able to sustain the proportional increases in packaging speed achieved by new cartoning machinery. Thus there has been steady pressure by packagers on their suppliers to eliminate the extra packaging steps by combining barrier materials with paperboard, creating what we refer to, for want of better words, as a single-wall barrier carton.

Some packagers have asked for additional properties in paperboard packages, too: elimination of messy gluing operations by pre-applying the sealing medium to the paperboard carton blanks.

Of course, when you eliminate an outer wrap you must put the product identification and sales pitch on the surface of the carton, which in today's marketing battle requires an ultra smooth board capable of very high quality gravure or offset printing. Fortunately, development of extra smooth virgin kraft and cylinder boards, inks, and printing techniques has been ahead of barrier coatings—and is likely to continue to improve at a very satisfactory rate.

Opening and reclosing devices are also necessary to gain entrance to tightly sealed cartons and to re-institute the barrier on multi-use containers.

There are some obvious ways to reduce barrier layers and apply easy openers. Let us look at some cartons developed during the past two years, which though not single-wall cartons do reduce the packaging steps, eliminating packager-addition of either an inner or outer wrap: Hermitet, Fibrematic, Pouch in carton and Fin-Seal.

These cartons have been used first by frozen food packers for syruped fruits in an attempt to get away from the metal-ended fiber can, which is both expensive and hard for the housewife to open. At best, though, I believe that they represent only developmental steps toward even simpler and stronger barrier cartons.

Already there are other paperboard containers that do not require careful folding and sealing of integral liners or a separate pouch-packaging machine: Klik-Web, Concora carton, Polar Pak, Expresso, and Calk-Seal.

Finally, combining various structural and functional advantages that have been developed in many previous cartons, an English company has devised the Diatite carton that not only provides the necessary barrier, but carries its own adhesive, too.

All of these cartons represent great strides forward, but they are not the ultimate in barrier paperboard packaging. Indeed some of them are subject to a good deal of controversy. Here's why.

There is no such thing as a single, all-purpose carton, and there probably never will be, because the two main classes of foods—frozen and dry -now being put into single-wall cartons require different degrees of barrier protection. Liquid packaging, when it comes, will require another set of properties in paperboard cartons. Since no packager will pay for any more barrier than he needs, you will have to develop three perfect packages: one for frozen foods, one for dry products, and one for liquids.

Frozen foods, in the main, must be protected from loss of moisture, which desiccates the product and produces what is known as "freezer burn." Recent studies have shown that minute pinholes between flaps in the corners of frozen food cartons permit only a very slight loss of moisture. By far the greatest loss occurs through the body of the board in single-wall structures.

Also, frozen foods vary in their protective requirements, with pies and like items needing much less protection than most loose-frozen vegetables. Thus, while you see frozen pot pies and fried seafood products in some of the new single-wall cartons, many packagers of general frozen vegetable products feel that no carton today provides a strong enough surface barrier to protect their products.

Dry products and mixes, on the other hand must be protected from water vapor and oxygen, too, if they contain fats. Even the slightest water vapor and oxygen, too, if they contain fats. Even the slightest pinhole in the flap area of the carton can let enough moisture and air into the carton to ruin delicate mixes or dehydrates. Thus, while the general surface of the carton must be impervious, great attention must also be paid to the construction of end flaps and their sealing to insure a perfect barrier. Whether some of the latest cartons meet these standards of perfection or not, again, is a matter of some controversy.

So far, we have been talking about better cartons for products that have always been in cartons. But why stop there. If the necessary superbarrier packages are developed, paperboard folding cartons could replace metal for many food liquids, and for industrial fluids, such as oil. There are, of course, already milk cartons and an oddly shaped tetrahedral container that is used both for milk and fruit drinks. But with all respect to these packages, the tetrahedral container is perhaps too oddly shaped for conventional storage and use in universal applications. It is also a one-shot container and is sometimes difficult to open without spilling. The milk carton is a little expensive for most general products. The waxed variety does not withstand low temperatures very well and, of course, cannot be used for oils.

There are folding cartons under development, though, that are reported to solve all these difficulties and still retain a low cost. The vast market for such a package is well worth some concentrated research effort.

While there are not too many guideposts to this package it must be stiff enough to prevent bulging under hydraulic pressure and must be proof against any penetration by the product. Seams and flap seals must not only be moisture-proof, but resist the insidious combination of hydraulic

spreading and product corrosion. This seems to call for a formidable combination of paper fibers and plastic resins and there is a good deal of argument as to how it can best be accomplished.

Though there is argument over virtually every function of a barrier paperboard package, sophisticated packagers rarely argue over one important factor in barrier packages: cost. One and all, they agree that if the requisite amount of polyethylene, foil, glassine, or what have you is applied to the board surface, with present techniques, the resultant carton will be too expensive for most products. And supermarket merchandising is too competitive, today, to permit a premium-cost package for such cut-throat items as cake mixes, drink-mix powders, cereals, and frozen foods.

It seems to me that new coating and laminating techniques are needed. And here is where you paper technologists need to help the converters. Some experimental work has already been done toward applying barrier resins on the paper machine and commercial boards have been made with plastic resins added directly to the pulp in the beater. It would seem to me that these points of application are unquestionably the lowest cost way of obtaining paperboard with high-barrier characteristics. Therefore, I would urge you to investigate in greater detail, not only high-speed techniques for commercially applying such resins as polyethylene, polypropylene, Saran, and vinyl to the paperboard surface on machine, but to study the most economical combinations of surface coatings and beater-added resins. With hold-out improved by subsurface resins, it may be possible to gain impervious single-wall board with far lighter extrusion coatings than are needed today.

Incorporation of certain resins may also boost rigidity of the board, permitting use of lighter weight papers for dry and frozen foods or increasing the strength and reducing bulge in packages used for liquid products.

With compatible resins, packager-applied adhesives may be greatly reduced in amount or completely eliminated in favor of economical heat-sealing techniques.

I know that you are constantly working on many general and continuing improvements in paperboard and that such extra investigations as I propose require a great amount of time, and detract from your everyday "housework."

In conclusion, we feel that the constant improvement in rigid and flexible polymer plastics and continuing developments in glass and metal containers, leave you with no other choice, really, but to shoulder the extra job of inventing dramatic improvements in paperboard that will capture the imagination of packagers and enable you to retain and expand the enormous field of barrier paper packaging. Start now to create those three functionally perfect and economical paper containers: one for liquid, one for dries, and one for frozen products.

Lake Erie

The Lake Erie Section of TAPPI conducted a one-day Folding Carton and Corrugated Box End Use Testing Symposium in Cleveland, Ohio, Jan. 21, 1960. It was attended by 189 technical men from Canada, from 17 states and from 22 cities in Ohio.

In the afternoon there was a five-paper panel presentation of the End Use Testing of Folding Cartons—from board mills through the supermarket. Each panelist's paper enumerated the tests made by his company of the properties of incoming and in-process materials and upon finished products that affect subsequent processing, handling, and final usage. Questions from the floor followed.

After dinner, Mr. Richard Walsh, of the Packaging Institute, presented an illustrated paper entitled "The Professional Man in Packaging." This was followed by a panel presentation of the end use testing of corrugated boxes which was similar in outline to the afternoon panel.

The large number of papers presented on each panel curtailed the question-and-answer periods. Those wishing further information should send questions to the speaker of their choice or to the sympsoium chairman for forwarding to the proper panelist.

WM. SCHOENBERG, *Symposium Chairman*

One Road to More Efficient Packaging and Package Making Operations

William Schoenberg

WE ARE meeting today to discuss the end use testing of folding cartons and corrugated boxes and we will open the meeting by reading from the scriptures, the Book of Genesis, Chapter I, verses 1 through 4.

> "In the beginning God created the heaven and earth. Now the earth was unformed and void, and darkness was upon the face of the deep; and the Spirit of God harbored over the face of the waters. And God said: 'Let there be light.' And there was light. And God saw the light, that it was good..."

According to Webster's New World Dictionary of the English language the word "test" is defined as "An examination or trial, as to prove the value or ascertain the nature of something."

"...and God saw the light, *that it was good.*" This "proves the value" of the light. Thus the light was *tested* and found to be within acceptable limits, which is probably the first recorded test result.

For thousands of years man has done likewise. He has developed his senses to the point that, through them he can judge the quality of his work to determine whether or not it is within acceptable limits for its intended usage. This "ascertains the nature of something" so, according to Webster, these trained skills *are* "tests." Based upon information supplied by these tests man has learned what to do so that if what he is making is not satisfactory it will become satisfactory.

Until recently, the only information to control quality in papermaking, converting, and in packaging operations was the information provided by the trained skills of their machine operations was the information provided by the trained skills of their machine operators. These tests were adequate for their time. They are not *always* adequate to maintain the higher standards of quality and the much greater uniformity that is demanded by newer, more sophisticated, faster machines and that is required by modern merchandising and by advanced technical standards. Yet these industries have not been able to supply their machine operators with tools that control quality as effectively on the newer, high-speed machines as were the trained skills on the older, slower machines.

To illustrate, about 35 years ago I was the night foreman of a packaging operation. We had three hand-fed, pneumatic scale machines, each set to fill, scale, and seal 35 packages per minute. Our machine operator was a whiz who used the "biblical" method. Before starting a new lot of cartons he would riffle through some of them, would squeeze open some cartons between thumb and forefinger and bend a few carton flaps. After each of these, and similar "tests" he would do something to the machine and it would seem to run faster or smoother than before. Much of our business was private brands and runs were comparatively short—mostly between 4800 and 36,000. Spoilage was less than 1%, and we averaged very close to maximum production speed hour after hour, month after month.

Then we installed a new high-speed, automatic-feed machine which was set to produce 65 packages per minute. The automatic feeding device eliminated the girl operator

WILLIAM SCHOENBERG, President, Lord & Schoenberg, Paper Industry Instruments, Cleveland, Ohio.

and otherwise performed the same functions as before—only about twice as rapidly as before.

Unfortunately, the automatic feeding device could only take the place of the girl when everything ran smoothly. When cartons were stiff or warped or when any one of a number of things would happen, the feed section of the machine would jam. These jam-ups were generally considerably more severe than those that occurred with the girl operator on duty on the slower machines. More cartons would be involved in a jam-up, they would be more tightly compacted and more would be totally destroyed. It would usually take longer to put the machine back again into operation. In addition to the higher spoilage, we had longer machine down time which was about twice as expensive per minute as before because we were losing about twice the production per minute as before.

The output of the new machine was consistently higher than the output of any of the older, slower machines. However, and this is important, the new machine failed to produce as high a percentage of its production capacity as did the older, slower machines.

We depended upon the trained skills and senses of our adjuster and operators to keep us out of trouble and to get us out of trouble when it developed on the new machine as well as on the old machines. On the new machine they were no longer good enough, enough of the time. Our suppliers and the machine manufacturer were cooperative, but neither they nor we could show our operator how to run the faster machine with the same efficiency that he achieved with the older machines. No one was certain where the fault lay—whether it was the operator, the carton, the adhesive, or the machine.

There was no way to measure the properties that controlled the performance of the cartons during the packaging operation—in fact, we did not know what these properties were—let alone, know how to measure them.

That was 35 years ago. Since then, in the packaging industry, and in the industries supplying the packaging industry (1) machines are running faster, some many times as fast as 35 years ago, (2) items are being packaged today which were not invented 35 years ago, (3) other items are being packaged which could not be contained in folding cartons and corrugated boxes 35 years ago, and (4) methods are now used in material handling, shipping, storing, and displaying which require new properties or accentuate old properties in folding cartons and corrugated boxes in order to satisfactorily protect and sell their contents.

Most of these factors require improved control, which, in turn, requires improved or new tests because one must be able to measure before he can control—one must be able to *measure accurately* before one can *control effectively*. Thus new or improved tests are needed to supply the degree of control that is required to obtain maximum efficiency from high-speed packaging and package making equipment and to meet modern handling and merchandizing methods.

A few months ago I was taken through the packaging department of one of our large, efficient, well-known merchandizing company's packaging operations. While there, I saw a machine adjuster squeeze open a carton between his thumb and forefinger—just as my machine adjuster did 35 years ago. They are making the same tests that we made 35 years ago and they have the same difficulties!

Testwise, the corrugated box factories and the folding carton shops also operate much the same as they did 35 years ago. More tests are being made. However, particularly in plants dependent upon central laboratory testing, the test information is primarily of the post mortem type which can only be used as historical data. In such instances, the only information available to the operator to control the quality of his production is still only supplied by his trained skills and senses. As a result, particularly when operating at high speed and when running difficult boards: (1) more scrap is produced than is necessary, (2) a greater percentage of inferior quality material is shipped than need be produced. and (3) machines do not run as fast as they could as high a percentage of the time as they should.

These conditions have been around packaging, carton making, and corrugating operations so long that many believe that they are a necessary part of these operations. The tremendous growth of automation in industry has proved that this is not so. The use of automation proves that one can obtain more production of higher quality out of the same equipment by means of more effective control which is made possible through the intelligent use of comprehensive, fresh information. Folding carton and corrugated box manufacture, as well as packaging machine operation, may not be particularly well adapted to many automation techniques. However, all can benefit from the intelligent application of the principle of automation by supplying comprehensive, fresh data to machine operators. Test information will not, of itself, control machines. That is the exclusive province of the machine operator. But, when he receives test information that he understands, in time for him to use it, he can make his operation more profitable.

In order to put such a plan into operation, three developments are necessary. The first concerns the fact that cellulosic materials frequently fluctuate with great rapidity as to moisture content and, as the moisture content varies, so do most all physical attributes, some as much as 10 to 25% with changes of only 1 or 2% in moisture content. Samples should be brought to equilibrium with a given test atmosphere prior to testing, which is time-consuming. Much valuable material can be spoiled before the test can be run and the information returned to the machine operator. This is true even with the so-called quick conditioning methods. Tests made upon samples that are not humidity conditioned can easily be off 20% or more, so are of little value—may even supply information that will cause the wrong decision to be made.

A radical approach to this problem is described in literature from Forest Products Laboratory which was published in 1951 and '52. A modification of this approach is now being evaluated by a manufacturer of corrugated board and boxes. The objective is to enable the catcher to measure flat crush right at the machine. Then, by combining flat crush and moisture measurements and by supplying a simple calculator based upon past history, results are expected in two or three minutes which will correlate closely with tests made upon samples that have been conditioned for 24 hours. The possibilities are particularly significant since it is believed that similar results can be obtained on any testing equipment where two or more metal surfaces are in contact with the test specimen.

Many of the properties that influence the performance of folding cartons and corrugated boxes, especially for some of their newer uses, have not yet been established. Likewise, the properties that control the performance of folding cartons and corrugated boxes during package filling and sealing have not all been identified. There are still unknown properties that affect the performance of paperboard in the processes of making folding cartons and corrugated boxes. When these properties are identified, tests to measure them can be developed and more uniform packaging materials and more efficient and more economical packaging operations will be assured. Knowledge of the results of such tests will frequently be of greater importance to machine operators in fabricating plants and on packaging lines than will information regarding the paperboard, per se, which is the basis of most current test procedures. Also, with such information, folding carton and corrugated box manufacturers can build containers that are better suited for many specialized purposes than can be done with the information now available.

Such information cannot be obtained by postulating only

and may be a lengthy project. The proof of and limits for criteria require production failures. Then it must be established beyond reasonable doubt that conditions, other than the one being evaluated, are identical—that the failure is not due to the changed tension of some nut or other apparently insignificant but important factor. In order for the machine operator to use such information most effectively he should be able to: (1) adjust his machine from test data so that he could *start* running, trouble-free, at high speed, and (2) readily modify machine adjustments to compensate for changes in the materials being processed, as shown by the test data.

To accomplish this effectively, the controls on the manufacturing equipment or machines should have some gage or device to indicate the level at which they are set. Many of the controls still in use as parts of expensive equipment still depend upon the "feel" of the operator. Some of the newer controls do have gages. Machine operation would benefit from the use of more controls with gages.

For example, an operator can have his machine running perfectly on a particular lot of material. He could have complete information regarding the material he is processing and regarding its intended end use. Three days, three months, or three years later he may have an identical lot to run. If his machine adjustments are of the "feeler" type he has no way of knowing what his machine adjustments were the last time and can only set up based upon intelligent trial and error. It is then likely that much unnecessary time, material, and money will be lost before the machine is in proper adjustment. From records of gage readings, he should be able to preset his machine to start running perfectly at major cash savings.

In conclusion, there are many different tests and various types of testing and all are useful. However, there is only one reason for making tests of any kind. This reason is so elemental that it is frequently forgotten in the heat of scientific discussion and obscured by technical gobbledygook. The only reason for making tests is to obtain information that will cause something to make more money for the company! The company makes more money when machines produce more, more acceptable material, more of the time.

Such results are most effectively achieved, particularly in intermittent type operations, by keeping machine operators continually informed with comprehensive, understandable information regarding the material they run, the goods they produce and the uses to which they are to be subjected—and by supplying the operators with adequate controls to put this knowledge to constructive use.

Such comprehensive test information provides better understanding and enables closer, more effective cooperation between the basic component producer, the package manufacturer, the packager and the end user. At each level operations then run smoother and become more profitable.

Mill Testing of Boxboard for Folding Carton Usage

Clyde G. Eckhart

We are surrounded today by people who are looking for the same properties from two sides of the fence. On the one side we have the converter who is interested in buying boxboard which can be made into a salable carton on an intermittent basis with a minimum of material and conversion cost. On the other side we find the boxboard manufacturer who is trying to make boxboard in a continuous operation with the least possible material and conversion cost. Both of these people realize that perfect performance is unattainable, and that inspection of the product will result in waste which increases operational costs. We as quality control people are called upon to supply accurate yardsticks or test methods which measure continually the degree of approximation of production to standard quality. These test methods, which serve as guideposts to maximum quality at minimum cost, are essential to keep both manufacturer and converter operating at a satisfactory profit level. We will try to describe tests we make on boxboard which we believe are measures of properties controllable in our operation, and which we believe are important to economical folding carton conversion.

Clyde G. Eckhart, Development Chemical Engineer, Ohio Boxboard Division, Packaging Corp. of America, Rittman, Ohio.

In a folding carton of a given size and style board thickness, weight, and appearance (printed and unprinted) are normally dictated by the customer. These board dimensions are easily measurable with a micrometer, basis weight scale, and a brightness meter or colorimeter. A normal tolerance is ±5% of the ordered caliper and weight, and ±3% of the average specified brightness. These characteristics are readily controllable under normal operating conditions within the specified limits. The TAPPI Standard tests covering these three properties are T 410 m-45, T 411 m-44, and T 452 m-48.

Cleanliness of both the top and back sides of the sheet is sometimes less than perfect, and visually acceptable tolerances are normally set up to allow processing of the board either to the customer or to other outlets.

Moisture content of board is measured at the end-of-the-machine by use of TAPPI T 412 m-53. In this test the board is weighed as sampled at the end of the machine and reweighed after moisture removal to bone dry constant weight in an Emerson drier or drying oven. The loss in weight divided by the original or wet weight is the per cent moisture. Board converted in most plants will be satisfactory for stability, printability, and scorability if the moisture content of board is within the 5.0 to 7.5% range. Ink drying time variation, cutting and scoring variation, curl and dimensional change are some of the problems commonly encountered if the board moisture as made is not similar to the relative humidity environment of the converting plant.

Board absorptivity relative to ink vehicles is measured and controlled with the Vanceometer. This photoelectric meter measures the rate of absorption of mineral oil or silicone oil by the board. The gloss of a thinly cast film of oil after 20 or 60 seconds indicates the degree of surface oil resistance of the board, which is controllable by stock preparation, sizing, and calender treatment. This test is currently being prepared as a TAPPI routine control test, and is widely used in the paperboard industry.

One of the most important properties required of paperboard is good printing smoothness. This property permits the printer to reproduce copy faithfully so that the finished print looks like the original or desired reproduction. There is no TAPPI Standard method currently for the evaluation of printing smoothness, although several committees have been working on this aspect for several years. We have developed a proof press test (*1*) for end-of-the-machine control board printing smoothness. The test involves the visual assessment of continuous solid and half-tone coverage at various degrees of overpacking on a proof press printing board at a constant ink film thickness. Board which does not produce continuous ink coverage at 0.010 in. solid overpacking or 0.007 in. halftone overpacking at 300 microinches ink film thickness is judged marginal printing smoothness. In most cases board can be manufactured which will print an ink film continuously at lower impression values, and this board has been found to produce commercially acceptable cartons almost without exception, regardless of the type of printing equipment.

Paperboard for folding carton usage must have good bending characteristics. The only TAPPI Standard test method existing for the evaluation of this property is the corner bend test which is extremely crude and unreliable.

A newly developed test employing a precisely built scoring

tester and standardized procedure is currently under consideration by the Paperboard Testing Committee. We have been using the BRDA bender tester in conjunction with a recommended testing procedure for evaluation of board bender for several years (*2*). This end-of-machine routine control control test makes use of variable width female scores in combination with constant width male rules at constant depth scoring impression to rate board bender. The narrowest width female score which may be used to form a satisfactory fold at 180° with moderate ironing pressure becomes the bending quality rating of that board. The board is evaluated after inking with a fast drying ink, and conditioning at 35% R.H. for 20 to 30 minutes before scoring nad folding.

We have had excellent results in predicting the printability and scorability of paperboard in converting plants by the use of these methods. Although our separation of marginal stock is not always perfect, we have been able to reduce excess waste considerably by the use of these tests. End-of-machine control testing of printability and scorability results in action which reduces the overall variation as well as within run variation so that the converter gets better running efficiency. Selection and testing of top liner pulps and waste fibers used in the grades of board manufactured is a necessary prerequisite to satisfactory end-of-machine quality.

Modern high-speed printing places vigorous stresses on the ply structure of cylinder machine boxboard. Not only must the white printed side of the paperboard remains intact under the high separation force of viscous inks on high-speed letterpress and lithographic presses, but ply separation must be absent after the high shearing forces of impression rolls on gravure cylinders during rotogravure printing. We test for top liner ply adhesion on paperboard by printing samples with tack rated inks on an IGT printing tester. An end-point test result is obtained when the accelerating printing cylinder produces failure where the velocity-viscosity product is greater than the cohesive ply bond of the top liner to the body of the sheet. Proper raw material selection, good stock preparation, and exacting paper machine control insure maximum bond strength for lithographic and letterpress printing.

In rotogravure printing of paperboard (especially in thicknesses over 0.028 in.) the substantial pressure developed in the nip of the impression roll and engraved cylinder produces ply separation unless the paperboard is firmly ply bonded. We test for the weakest ply bond in cylinder boxboard with a ply bond mullen test which was developed by Robert Gair Co., Inc. (*3*). This test measures the magnitude of the weakest internal ply bond in the board when forces are applied perpendicular to both surfaces. Here again raw material selection, stock preparation, and machine control are important in the development of maximum ply strength.

Customer requirements for extra strength and/or stiffness are checked at the end-of-the-machine for conformance to specifications. Items such as hardware boxes, accessory and parts cartons and other bulky item cartons usually require somewhat stronger sheets for satisfactory packaging. Mullen or bursting strength, Elmendorf tear and Taber stiffness are routine control tests on extra strength boards to insure carton uniformity.

We feel that improved test methods are necessary for the numerical assessment of boxboard printing smoothness. We believe subjective evaluation of proof prints on an absolute basis or by comparison to preselected standards has merit. We feel, however, that an integrated numerical rating of the degree of boxboard smoothness contribution to the printability of a given job is essential for better routine control of boxboard manufacture.

We feel that an improved test method is necessary to predict the gloss ink holdout of clay coated boxboard. While the present test method appears to be relatively satisfactory for uncoated boxboard, a rapid routine indicator of ink absorbitivity on coated boxboard is essential for more uniform boxboard manufacture.

We have been able to predict performance satisfactorily in the folding carton plant for the most part. In some cases varying conversion requirements and procedures have resulted in unsatisfactory performance, but we have been able to adjust to these requirements by understanding the properties required. Our aim is to satisfy the ultimate consumer, and our quality control is geared to accomplish this with the help of the test methods we have covered.

LITERATURE CITED

1. Lewis, R. L. and Eckhart, C. G., *Fibre Containers and Paperboard Mills* 46, 89–92 (May, 1957).
2. Lewis, R. L. and Eckhart, C. G., *Boxboard Containers* 74, (763) 37, 39, 41 (July, 1956).
3. Donahue, J. F. and Verseput, H. W., *Tappi* 40, 311 (May, 1957).

Testing Board for Coating and Testing Coated Board for Folding Carton Manufacture

Ivan L. Lester

TODAY'S market for specialty packaging has created a situation in which papermaking is no longer an end in itself. It no longer produces a finished product, but rather it produces a material which is a raw material for the boxmaker who must print it and cut it and make a suitable container that will sell in the final market.

We have come a long way from the days of our childhood when packaging usually meant the clerk in the little corner grocery putting some sugar or beans into a paper sack and handing it to the customer across the counter. The change has been rapid, but at the same time it has been subtle enough that most people do not stop to think how involved this new concept has made the lives of everyone. It has created a whole new industry within the packaging industry itself; it has changed the complexion of paperboard making to such an extent that today we make demands on the boardmaker that would have been unheard of 20 years ago.

Vance Packard's book, "The Hidden Persuaders," clearly describes the change. "Just putting the name and maker of the product on the box is old fashioned and has absolutely no effect on the mid-century woman. To get the woman to reach-and-get the package, designers are now using symbols that have dreamlike quality. Examples of the dreamlike quality are mouth-watering frosted cakes, sizzling steaks, mushrooms frying in butter. The idea is to sell the *sizzle* rather than the meat."

For the boxmaker this has meant the adoption of newer and more complicated printing processes, machinery operating at higher speeds to take care of the vast market, and the need for raw materials which will function in these machines. This has lead to complications in the form of demand for new and different types of materials, and for greatly improved characteristics of older types of materials. And has forced the boardmaker to bring out new products and to institute new processes.

Although it now has a history of about 15 years, the *coating* of boxboard is one of the newest of these procedures that the boardmaker finds himself operating. To the converter, the search for the right kind of coated board has led to the continued study of the technical problems of relating boards and coatings to printing presses and inks.

Coated boards are in demand today for the very same reason that coated paper became so important in the 1940's and have continued to increase in popularity. The demand for coated boards by boxmakers today is based on the fact that today's package, more often than not, must reproduce with great fidelity drawings, color photographs, and other forms of art

IVAN L. LESTER, Technical Director, Mead Packaging Division, Mead Corp., Atlanta, Ga.

work, and be capable of trouble free operation at relatively high speeds.

WHAT DO WE LOOK FOR IN A COATED BOXBOARD?

The attributes of any board are defined as the needs of the ultimate product. And since, regardless of the kind of board, the boxmaker wishes to make a box or carton that will hold the product for which it is designed. It, then, is necessary that the first attribute of the board is its functional capability in making a box.

One of the serious mistakes that is often made with coated boards is that a designer will accept a board in the same basis weight and caliper as he would accept in an uncoated board. He forgets that clay coatings add nothing to the overall strength or tear or stiffness of a given boxboard. And that 5 lb. of coating does not replace 5 lb. of fiber.

Since we are in today's packaging market and must print our board, the next important thing in a coated boxboard is its *surface*. It must be capable of being printed to render the most faithful reproduction of art work designed to sell the packaged item. Its surface must be level. It must have uniformity of brightness and color and it must have uniformity of ink holdout. The coating must withstand the strains and stresses of cutting and folding operations without cracking. And in many instances, it must render some functional special service, such as resistance to water or resistance to oil.

In order to evaluate a boxboard we find it necessary to measure the bonding of the coating—"pick resistance," its uniformity of ink absorption, the smoothness or levelness of sheet surface, its color and brightness.

Pick testing by the old Dennison wax procedures was good until somebody put latex into the coatings. Latex binders form wonderful coating, especially for the boxboards, but the Dennison wax test no longer is suitable since it tends to destroy the bond and to give erroneous readings. Presently, we are having considerably better luck by using *tack-rated inks* and printing samples of the sheet with these inks on a proof press. At least we are able to determine how well the coating will hold and not pick off when tacky inks are applied to it.

Newer still, and an item that is not yet in general application, is the IGT tester; which not only combines the effect of tacky inks, but also their flow properties under high velocities and high pressures as they affect the ability of the coating to withstand picking.

I do not feel that the subject of picking should be left without briefly mentioning that problem which we call "trash" or "dirt." Many times a boardmaker will get a complaint that his board is picking because the pressman is getting trash on his printing plates and consequently getting spots in his printing. When actually, the only thing that is happening is that the boardmaker has not been scrupulous enough in the cutting and trimming operations to keep slitter dust and other miscellaneous debris off the surface of the sheet. The same effect can sometimes be noted by dirtiness in the coating operation itself. You may have a perfectly good formulation that will bond to the sheet and will stand normal printing activity. But, if partially dried clumps of coating are picked up from rollers and guide bars and left bonded, but only lightly bonded, to the sheet, they will pick off. It requires careful examination by the boardmaker to determine the exact defect.

UNIFORMITY OF INK ABSORPTION

The variation in the board surface as to its absorption of the inks from point to point across the printed surface is one of our major printing problems. This occurs particularly in print copy designs with heavy solid coverage. It is particularly noticeable with the use of metallic inks, such as the golds. Under no circumstances is it limited to the metallic inks. Due to the nonuniformity of the surface we tend to get areas where we either have concentrations of color in one spot or a washed out appearance in spots. The measurement of this factor is difficult. Many papermakers use an oil-drop test which tends to measure the time of the complete absorption of a standard oil. Many of us use the Vanceometer, but we find that its use is limited especially in coated boards due to the fact that coatings generally have a good ink holdout. The instrument does not really measure the difference in uniformity of ink absorption between small individual areas. Rather, it integrates a relatively large area to give its anwser.

Short of visual observation and practiced judgment the oil drop test, the Vanceometer and similar methods can only be described as good tools. They still need to be specified and they still need to be used.

They are important in evaluating the uniformity of a lot of board from the beginning to the end of a run. They are important in evaluating the difference between boards which soak up ink and boards which hold it out.

The use of such inks as the K and N should not be overlooked since this will give a good visual observation of how ink will be absorbed by a given sheet.

LEVELNESS OF SHEET SURFACE

First, let us distinguish that we are not talking about variation in caliper. This is gross and can be readily identified. Smoothness or levelness comes in more subtle measurement. There are many procedures which attempt to evaluate smoothness. We all remember the Gurley smoothness tester. We are familiar with the Chapman instrument and similar instruments. Unfortunately, each of these instruments leaves something to be desired. Because they either measure too small an area or they are affected by other characteristics of the board which tend to reduce the effectiveness of the measurement.

We usually end up by trying to visually compare a smooth board as a standard and saying that our sample is smoother—or less smooth—than the standard. Along this line techniques have been developed for photographing the board and making this comparison photographically. Bob Regan of Chicago Cartons, who is on the panel, was a part of some of this work, as were several others of us. We still have not—in this area—developed a test that can be reported in numbers.

I believe the nearest approach to this is the work of Tom Zentner and others at Diamond National Corp. with their printability tester which is really a small gravure press, printing under controlled conditions and in such fashion that if the board is rough, more of the dots will be dropped out of the print screen, thus indicating the lack of smoothness. This instrument is being used for board mill control and certainly gives the paper producer and the paper user a tool and a method of numerically evaluating sheet smoothness.

COLOR AND BRIGHTNESS

The paper industry, over a number of years has tended to talk of brightness. It has standardized instruments which measure the reflectance in the green band of the visible spectrum. This is not a color measurement or a shade measurement. We are familiar with the fact that two shades may have the same brightness, that is, the same percentage reflection at 457 μ—and yet they will be widely different in color. The paper and board industries have attempted to meet this by establishing samples for color and shade which must be visually matched. In general, most mills seem to be pretty capable of matching and delivering the proper shade if they have been given the proper standard. It is up to the boxmaker to determine what he wants and to clearly specify it to the mill. But again, uniformity becomes the problem, and we find it necessary to check lots of board for shade variation within the run. Today's printing, with its pastel shades and transparent inks, gets into trouble if there is severe variation in board color. The carton maker

gets into trouble if some of the boxes are white and some are yellow in the same run. The purchaser of boxes and his advertising and marketing departments take a very dim view of such variations when they are thinking of mass displays in supermarkets.

FUNCTIONAL REQUIREMENTS OF THE COATING

Long before coating came into being the boxboard maker had to face many special requirements of making a board that wouldn't crack or a board that would bend easily or some other such characteristic. He is not relieved of these problems in coated boards. It is possible today to make coatings that will cut and will bend. And, it is a requirement that coatings on boxboards designed for folding carton construction must satisfactorily crease and bend. Most boxmakers will at least hand crease samples of the board to see how well it acts. They may make test cuttings on a platen press and more recently the score bend tester is being used very effectively in the boxboard and carton industries to evaluate the folding characteristics of boards.

There are very few boxes made that do not require gluing in their processing or in their filling in the final packaging operation. It has become common practice to specify the condition and type of gluing to which the board will be submitted. Many times it is necessary for the papermaker to modify the coating and the structure of the board underneath, to make sure that it can be properly glued. An attempt to measure and evaluate this characteristic has resulted in the application of tests ranging from water drop absorption to actual gluing tests. These methods are specified in some of the Tappi Standard and Routine Control tests and sometimes there are specialized versions of these tests.

I have appended to this paper a list of the Tappi procedures in the various areas of tests and have appended a description of other test procedures where they do not appear in the Tappi Standards. This list has been distributed to you.

With today's ever changing box designs and the high-speed filling applications of modern packaging, every new application becomes almost a project in itself to measure and determine the characteristics that are desired. There are many areas in which we do not have answers, but the intelligent cooperation and consideration of the box user, the boxmaker, the papermaker, and the manufacturers of all the other materials that go into making a box *can* successfully meet these problems.

Testing Boxboard for Folding Carton Fabrication and Testing Folding Cartons for Packaging and End-Use Performance

Robert O. Ragan

With all the pretesting of board materials by the manufacturer, it might be assumed that the carton maker shouldn't have to test again if he has provided proper specifications on the order and if these specifications have been clearly understood, and closely followed.

Then why do we make tests?

1. We must predict by our own tests and their interpretations the performance of the board in our box making equipment.
2. Certain specifications by the customer must be met, and these may not be a responsibility of the board manufacturer.
3. The policing action of a sure testing of all shipments keeps the supplier alert. This reminds me of a decision I once heard made in a paper mill. The run of a certain paper met all the specifications by the customer except the tear strength was down. Knowing the relative unimportance of tear strength in this grade of paper, the mill superintendent called the salesman handling the account.

"We're having trouble getting the tear up on XYZ's run. Everything else is O.K. Do you know how fussy they are in their testing?" he asked.

The salesman answered, "I've never seen any of their test reports, and I'm not sure they even have a test lab. We've never had any complaints."

Superintendent: "If it is O.K. with you, I'll let it run. If we mess around to get the test up, we're going to lose a lot of machine time."

Salesman: "Try to get the test up, but don't hay out. We'll take a chance on shipping what you've already run."

Robert O. Ragan, Technical Handyman, Chicago Carton Co., Chicago, Ill.

Let us first consider the inspection and testing of the incoming board with regard to our own manufacturing operation, then we will take up testing in consideration of specifications which have been supplied by the carton buyer.

INSPECTION

The board shipment is first inspected for general physical condition. These matters are so obvious that I hesitate to mention them here, but some of the simplest of physical mistakes can cause the most manufacturing trouble and lost time. The important considerations determined by inspection of the shipment are described below.

Shipping Damage

(A deep dent in the end of a roll of board can cause press down time due to web breaks.) Such things as gouged or dented loads or rolls, shifted piles on skids, collapsed cores in roll stock, broken skid legs, torn outer wrapping, contamination with foreign material in the car, or damage from rain or snow enroute.

Direction of Piling or Winding

Whether the printing side is up or down, or wound in the roll inside or outside. We once received a large shipment of roll stock which was wound the wrong way. In answer to our urgent phone call, we were asked by the mill if we couldn't turn our rolls end-for-end and unwind from the bottom; they didn't see how that could make a great difference. So, we ran the press at half speed because the up curl of the sheets wouldn't feed into the pile delivery, and all the roll splices were made by hand because the flying splice wouldn't work in the opposite direction.

Flatness of Sheet or Pile on the Skid

Modern, high-speed, sheet-feeding equipment won't put up with much nonsense in the condition of the pile of sheets.

Identifying Markings

All shipments must have markings which are necessary for proper inventory control and stock issue, as well as identification to the mill if there is a complaint. Take, for instance, the simple matter of marking reel or roll numbers on the rolls. Sure, all the dope is on the roll wrapper, but when you're half through printing a roll and run into a bad mill splice which causes press down time and a complaint is to be made, which roll is it? The wrapper is already trampled down on the scrap pile. The roll shafter isn't sure of the number. That is why it is well to have the identifying marking also on the end of the roll itself next to the core; as long as there is much of the roll left, so is its identification. It is costly to spend the press crew's time for bookkeeping activities. It should be the responsibility of the board mill to provide proper and adequate marking on each roll or skid of stock.

SAMPLING

So far in our discussion all we have done is look at the shipment, so now let us get on with the actual testing. This leads us to the biggest problem of all in the whole testing and control activity. Where and how can we get a representative sample of the board? If we sample the outside of a 69-in. roll weighing 6000 lb. this may represent only

one sample per hour on the board machine, and a lot can happen on a papermaking machine in one hour. For the sake of our own records, we can take additional samples when we run the roll, but then it is too late to reject defective material and replace with a like quantity in time for the job. In lieu of a better method, we ask the board manufacturer to collect and to send us samples which correspond to the rolls or skids. In so doing we are certainly depending upon the integrity and care of the board manufacturer in selecting the samples.

Sampling the top portion of skids of sheet stock is not always reliable, either. Sometimes the height to which the skids are piled is adjusted at the mill in the shipping department by piling on a few inches of board from another skid. So, it is necessary for us to unband the skid, lay back several inches of board in order to take samples further down in the pile. Then if the skids of board are to be stored double-decked, they must be rebanded. All this labor costs money just to get a sample.

The problem of collecting representative samples of paper or board is old, but, it still has not been thoroughly solved. It should be attacked with a cooperative, united effort on the part of the board manufacturing-carton converting industries as a whole.

Let me cite another instance which shows the importance of proper sampling. A carton manufacturer asked the board mill to supply samples of board corresponding to the large rolls which were shipped. Not that he was skeptical, but as a double check, the carton manufacturer compared the mill samples to those he himself took from the outside of each roll, and found excellent agreement. There was some color variation but it was well within tolerance. So the rolls were double sheeted, cutting 2 rolls simultaneously. Now somewhere down in one of the rolls the color took a sharp deviation, but it was not detected until the printing department noticed that every other sheet on the printed pile alternated from maximum light to maximum dark. None of the mill samples, nor the board samples taken from the outside of the rolls showed the particular off-color. Carton buyers do not appreciate the opportunity to select the color they like, especially if a choice between two hues is in each packer. Maybe you have some suggestions for what to do in a case like this?

Perhaps the answer lies in the development of an automatic sampling device to be installed on the dry end of the board machine. The "Sample Snatcher" would automatically grab a sample according to a predetermined time cycle, simultaneously tape or repair the hole in the web, mark the time on each sample and store the samples in a locked compartment which would be sent unopened to the board user along with the shipment of board. This would be as welcome as Green Stamps.

Assume that by some means representative samples of the board are obtained, what properties should be investigated to determine fabrication performance?

Universally applied to most all grades are the following tests made to determine fabrication performance, as well as some customer specification. The kind of test and mention of the method is given here. If is not the purpose of this paper to elaborate the tedious details of the tests. We test:

1. Basis weight; on a ream weight balance.
2. Caliper; in the usual manner. Deviation here may affect printing and scoring.
3. Moisture content; by pulp oven tests overriding any quick instrument tests. Moisture content equilibrium at factory conditions—the exact moisture content is not as important as being in equilibrium.
4. Surface characteristics; roughness by examination with oblique light across grain.
5. Stiffness; by Taber tester.
6. Scoring and bending; by platen press scoring and hand folding to watch for liner cracking.
7. Color; visually compared to a standard, or Densichron instrument.
8. Odor; samples sealed in glass jars, both dry, and also with moisture; oil vessels enclosed. Held at 120°C. overnight.
9. Sizing; water drop, or Cobb ring, using the minimum time, to determine the extent of sizing.

Extraordinary, or more specialized tests are applied to board specifically to determine individual job requirements:

Printing Surface. The most reliable method for determining half-tone printing surface characteristics is through the use of photomicrographs taken at 25 × magnification with oblique light, across the grain. This is supplemented by visual inspection to locate the roughest spot to photograph, and for doubting Thomases, we sometimes pull a gravure half-tone proof on a lab press. This photographic procedure was presented at the National TAPPI meeting and is published in *Tappi*, June, 1959.

The Vanceometer, using mineral oil, and a 20-second test we have found of some use in measuring gloss holdout for gravure inks and gravure varnishes. The test is also supplemented with lab gravure prints of solid ink and varnish.

The Vandercook proof press, using tack rated, or gloss-rated inks, has proved more reliable for oil-ink printing.

Pick Test. The wax pick sticks are not as reliable as the power driven Vandercook with a tack rated ink for measuring the pick resistance of a clay coated board. If the wax pick tests are well over the critical value, however, then proofing tests are frequently not made.

Wax Holdout. This property is becoming of more concern on solid bleached clay-coated boards and on the many new board treatments. Although of no help to the board mill, our tests are run on the commercial waxing machines. A fairly reliable lab test is to wax-dip the test strips for 2 seconds in wax at 220°F., a quick flip, then plunge into *still*, cold water. This approaches the discoloration experienced on the cold water waxing machine under normal operation, but the surface of the wax is rougher.

Curl Tendencies. High-speed machines call for paperboard free from curl. A study of the factors governing roll-set in paperboard would be a worthy subject for a doctorate thesis. Roll-set is like money, everybody has some, but at times a lot more than others. Decurlers are not always effective or applicable. To measure roll-set, cut a circular sample the size of a dinner plate from the web and in a free hanging position note the extent of the curl.

The tendency of board to curl with changes in surrounding humidity can be observed by hanging strips in large jars containing various humidity-controlling salt solutions. In this way a range of humidity from 30 to 70% R.H. is readily obtained. The test samples are thoroughly conditioned under standard TAPPI conditions before placing in the jar. The extent of curl can be physically measured.

A modification of this method relating to curl in laminated compositions is to adhere, with double faced pressure sensitive tape, the board strip at each end to a strip of 0.004-in. thick steel doctor blade stock. Expansion or contraction of the board as the case may be causes a bow between the steel strip and the test strip which can be measured. We find that the results rate the relative hydro expansivity of boards in the same order as the tester developed by The Institute of Paper Chemistry. The strip test is admittedly crude and not as accurate, but use of the simple jars permits a convenient, broad range of humidity conditions, and the apparatus doesn't cost much.

Surface Smoothness for Foil Lamination. This is a test yet to be developed. Air flow tests on the board surface give only the barest indications of the extreme cases of rough and smooth surface after foil lamination. It is comparatively easy in the laboratory to make a test lamination of foil to samples of board, and the comparative roughness of the foil surface can be observed, but how do you measure it numerically?

Grease Stain Must Be Measured on Trays and Food Boards. The penetration of the shortening through the board and/or

discoloration can be determined by placing a very small quantity (1/4 to 1/2 g.) of shortening measured on the end of a spatula in the middle of the sample cut to fit a Petri dish. Penetration time and dicoloration is then observed at room and at elevated temperatures, depending upon the use requirements.

Except for coatings or films expected to be absolutely grease impermeable, the use of the turpentine test on board can be very misleading. It is the appearance of the grease staining which is important. For that reason it is best to make the tests with the product itself, or with the shortening which is in the product.

Rancidity. The rancidity influencing properties of the board can also be tested by the Petri dish method, using a butter cookie as the product. A single cookie is placed on the board sample in the covered Petri dish and held in a dry oven at 120°F. A cookie in contact with the glass alone is used as a control, as there is no such thing as a "standard" cookie any more than there is a standard shortening. The Petri dishes have the advantage of easy opening so that it is no problem to smell the samples as often as desired. With a little training it is possible to establish the end point within one day, and sometimes within half a day.

The performance of the cartons on the customer's filling machine is of utmost importance, and if the cartons do not form and seal properly, it doesn't matter how good they might otherwise be—they are still no good.

Certain physical properties of the board itself have been found to be closely related to the performance of cartons on the filling and sealing machines. The most important attributes are cluability, and score break resistance, and at times these functions are so closely related it is difficult to determine which is the controlling factor. An illustration is a carton which does not have a tight end seal; the spring back, or the so-called "fight," in the end flaps tending to cause them to pop open is greater than the rate of glue set. Both properties are inherent in the board.

Many instruments, or test procedures have attempted to define the glue bonding characteristics of carton board, and so far there is no simple lab test. This is still an unsolved problem but an important one. Conventional board sizing tests, such as the Cobb, or water drop are only an indication of extreme limits.

The Concora folder gluer is a miniature, straight line, glue machine which is reported to show considerable information regarding glue-setting time on various board surfaces but has limitations when applied to carton end-sealing problems.

Consider the diversity of carton forming and sealing systems found in packaging plants.

Some machines slop a heavy layer (it is too thick to be called a film) of adhesive on the inside of the board, and hold the flaps closed in a compression belt, the length of which seems to be determined by the length of the room. In contrast are machines which carefully meter a very thin film of adhesive directly into the flaps, while other machines spot the adhesive with a transfer wheel or pad. Some applications are to the inside of the carton, some to the outside. The modern trend is to apply a dot pattern of adhesive from an intaglio or knurled glue roll. On some machines the glue must set in 1 to 2 seconds, on others, up to 30 seconds holddown is found.

Take the manner of compression belts. Due to the carton size, or nature of the product, some machines apply enough pressure to squeeze the adhesive out of the seam; other sealing machines have pressure belts which are nothing more than conveyors with good intentions. Some filling plants like 'em hot with heaters to set the adhesive, others run 'em cold.

If this isn't variety enough, you should now multiply all of the above confusing factors by two, considering that either a dextrin, or a resin emulsion type adhesive may be used.

It becomes apparent that a simple Cobb, or water drop, or even a smearout of the adhesive on the board cannot possibly give all the answers.

There needs to be developed a gluability tester more versatile in duplicating actual machine conditions. The adhesive accepting characteristics of a carton cannot be divorced from the spring-back nature of the sealing flaps.

The Ohio Box scorebreak tester can be used to measure this property. It has shown that poor gluing at times is caused by strain on the glue ply due to stress resulting from inadequate scoring. The instrument can also be used to measure the force required to open a carton, or to fold a score. The problem which arises is the lack of experience on the part of the carton manufacturer in regard to what limits are actually required on the setting-up and filling machines. The recommendations of the carton user are needed in this respect.

The scorebreak values vary with the type of scoring, and are also drastically affected by the board composition, with so far no evidence of even a close parallel between stiffness characteristics and scorebreak values. Until more data and experience are available, the meaning of the scorebreak values is not always too clear.

Another purpose for the testing program in a carton plant is to see that the customer's specifications are met. The purpose is to give the carton user what he asks for in every detail.

The customer specifications most always define the board by grade, caliper, weight, stiffness, and sometimes tear and burst and moisture content. There is usually an attempt to insure good gluing by some definition of water drop or other sizing test. As explained earlier, these sizing specifications are inadequate, and may be more harm than good if in meeting such tests the board mill sacrifices other more vital properties, such as printing smoothness.

There are always use requirements specific to the particular carton. Sometimes these specifications are supplied by the carton user, but all too often the skill and experience of the carton producer is not used because the customer does not say exactly what he expects the carton to do. In other words, the specifications are in terms of exact test values instead of use requirements. For instance, the weight of wax is specified instead of water resistance or MVTR requirements.

Some of the more common special tests are: rub tests on ink in the Sutherland, or customer supplied apparatus; fade and bleed tests to determine the reaction of the product on the ink and board; glue bonding, and special tests to establish the permanence of the bond under adverse conditions; wax content in an attempt to define moisture or water resistance as mentioned before; brightness and other optical measurements to establish uniformity of appearance; mold resistance or chemical tests tying together reaction of product and package, or affect of package on product.

Strength tests of a destructive nature, such as ring crush, water soaking, or bulge tests are often devised to show performance of handling and merchandising.

Protective properties, such as weight loss of product, or moisture pickup, or required storage life are usually of concern in the development of a new carton or material. These tests are usually too involved to use as a manufacturing control test.

To summarize the general topic of the specifications given by the carton user to the carton manufacturer, the problem is not that test specifications are lacking, but many times the purpose for a test, or its significance, may be questioned.

We could talk on-and-on about the specific details of carton testing, but after all is said and done, is such a testing program really necessary, and what does it accomplish? How can the effectiveness of a testing program be measured, or justified against its cost.

In your own plant you can readily find the answer; isn't it usually the lot of board which didn't get thoroughly tested which causes the trouble? It seems that nothing can happen,

or is ever found wrong with the portion of the run, or the property, which has absorbed all the man-hours of testing. But perhaps that one load which was rejected saved the company more money than you can figure.

No testing program can afford the cost of completely testing each and every variable, but it often pays off to make spot checks of some of the other variables which are not routinely examined. Too often, complete testing is concentrated on the wrong physical property. For instance: in a campaign to improve stiffness, take a look at the printing surface for it may have suffered unsuspectedly. Or if improvement in the printing surface is the problem, better check for liner splitting. These examples illustrate the close relationship of all of the variables, and no one factor stands independently alone.

There are bound to be undetected defects which sneak through any testing program, and such instances provide managerial or supervisory personnel opportunity to vent their invectives, but if the testing program is really working, such defects are corrected or such material is rejected before the next run. The absence of recurring trouble of the same kind is therefore a measure of the effect of any testing procedure.

In conclusion, let me say that any test procedure is only as good as the personnel employed and the tools used, and in turn the tool must fit the problem. But before the shape and size of the problem is known, it must be defined. Isn't this quite often the area which sabotages effective testing, i.e., the lack of proper definition of the problem through fear of "educating" the customer or supplier? Board manufacturer, carton fabrication, and carton user are all on the same team. Let's all agree on a set of signals, call them loud and clear and then turn the instrument manufacturers loose in the field. Too many do-it-yourself procedures are basically unsound, or have been misapplied to problems for which they were not designed. Any mechanic knows it is not proper to use a pair of pliers on a hex nut. Let's be likewise careful in the use of our paper testing tools.

The Problems We Experience with Folding Cartons

William W. Adams

It is gratifying and a little terrifying to find yourself representing retail grocers on a panel such as this. It puts me in mind of the story of the unbreakable toy turtle. It seems an engineer developed a toy turtle that was designed to withstand great pressure through reinforcement of the various stress points as indicated by exhaustive laboratory studies. Satisfied he had created the fractureproof toy that would mean great fortune for him, the engineer, who happened to be a bachelor, gave one of the first toys to a friend of his with several young children. As you might guess, the turtle and the engineer's dreams were shattered in a few days. When questioned by the distraught man, the children readily admitted they had ridden bicycles over it. A natural use for a toy to the user's mind, but one that laboratory tests never anticipated.

I do not plan to ride any bicycles over your folding cartons, but I will give a nontechnical, down-to-cardboard retailer's viewpoint that you may find profitable. If this adds a little weight to the quality control group in its tug-of-war with production, then any efforts put forth will be worth while. More and more it has been brought home to us in recent years that price is much less significant to a sale than a sound product in a sound and attractive container.

The primary packaging consideration that is all important to the retailer is that of *adequate protection.* All other considerations are predicated on the supposition that the container will protect the product through its expected normal shelf span both in the store and on the consumer's pantry shelf. This includes reasonable amounts of abuse.

An example of this would be the soft drink carton that often manages to get wet somewhere along the line. When a coke bottle falls through the weakened bottom of its carrier, the retailer bears the blame and the expense of replacement.

The leaking soap powder container that flavors other products in the same bag reflects in the shoppers mind on Fisher Foods or A and P or Kroger.

The cake mix that does not produce the glorious creation shown in four-color magazine ads is frequently our fault. Granted in this last example that a cake mix packed in concrete and steel will not help a half-baked housewife, there still may be room for packaging improvement.

An overwrap of cellophane, a better inner package, air-sealed cartons, whatever the solution, this is the principal problem that cardboard containers give the retailer. All other considerations must presuppose protection.

The following check points highlight the retailer's outlook. Some will affect you directly, others indirectly, but all should be worth consideration.

THE SELLER'S SLANT

Storage Prior to Sale. Is this a fast turnover item that is assured of short storage life?—Blueberry muffin mix has to be packaged for longer backroom and shelf life than devil's food. Many stores do not move a case in a month or more. A dozen cartons may sit in a damp, dusty back room long enough to put the utmost demands on the package. Will your carton meet the test?

Unit of Sale. Is the carton too big to handle easily? Is it too large to price reasonably? Will the size of the package lend itself to multiple unit sales (multi-unit sales are not quite so important today as they were even five years back)?

Display. Is the package destined primarily for shelf, counter, or window display? Is the shape and size of the package adapted to mass display? Will it stack or do the packages hump; does it take a juggler to build a display and the first buyer to shatter it? Is the product to be contained so heavy in relation to the carton that high stacking becomes impossible? Will the package be displayed primarily at, above, or below eye level? Will the package be shelf displayed on end or side? Will this package conform to the majority of similar products on the retailer's shelf?

CONSUMER CONSIDERATIONS

Is the package adapted to consumer buying habits? (Which means *using* habits.)

Would any change in package size affect consumer convenience? For example, small size soap powder boxes are easy to handle. The largest boxes are awkward to handle for pouring, but can be used with a dipper. The middle sizes are often too big to pour and too small to scoop.

In products that are not generally used at one time, there should be a way to reclose the package (either inner wrap or carton).

In products where half the contents could make a frequently usable unit, a double innerpack is desirable (as in Dromedary cake mixes).

Is the carton easy to open by a housewife? (Housewives use weak fingers and fragile fingernails, not carton cutters).

Can the homemaker stack this carton in any of several positions and still be able to read what the product is?

If the contents are to be poured, is a spout provided?

COMPETITIVE CALCULATIONS

How does the package compare with direct and indirect competition? (One tea carton against another, and against coffee containers.) (1) Materials? (2) Size and shapes? (3) Color and designs?

Does the package identify the manufacturer where this is significant? (In soap powders it is of no interest to the house-

William W. Adams, Assistant Public Relations Director, The Fisher Bros. Co., Cleveland, Ohio.

wife whether P and G or Lever is the maker, while in baby foods the Gerber baby drawing has proved a wonderful and necessary trade mark for quick identification.)

Does the package adequately feature the product name for immediate identification? (The pictures of cut cake on mix boxes are excellent, especially the new Duncan Hines line. Have you ever tried to find a particular cereal from the vast cereal group?)

Does the package reflect the outstanding features of the product? (E.g., a foil wrap can add distinction and sales as in the case of Lux soap. In this case the desire for freshness in food has some transfer value to a product where freshness has never been a consideration.)

Are the colors and design:

1. In good taste?
2. Appropriate for the product?
3. Competitive (Fishers upped sales on private label tea bags by pepping up the package).
4. Distinctive (Wheaties is the only cereal that can be found fast).

Will the package make a strong impression:

1. From a distance?
2. Up close?
3. On the shelf?
4. In a display?

Does the package sell itself? (Self-service leans heavily on impulse attraction, this is one reason why pictures of food products are often so successful.)

Is the package memorable? Will people recognize it on future shopping trips?

SUMMARY

To be effective a package must:

1. Protect the product.
2. Identify the product.
3. Identify the brand name where necessary.
4. Arrest attention (be different, while appealing).
5. Stimulate the buying impulse.
6. Facilitate satisfying product use (e.g., easy to open, pouring spout, re-closable inner pack or flap, etc.).

SUGGESTIONS

1. Place printing so that carton may be displayed on end or on its side. For example, Sunshine Chocolate Chip Cookies.

2. Cut down duplications. Too many sizes of same item, especially in cereals and soap powders. The resulting shortage of space cuts down the representation of all products and sometimes keeps worth-while items entirely off the shelves. (Has anyone bothered finding out what size or sizes the *consumer* prefers?) The retailer is growing ever angrier at being forced to carry multiple sizes for multiple competitors with no accompanying increase in total sales.

3. Too much writing and too many gimmicks on many packages. A customer sometimes has to read the fine print to ascertain whether a package contains soap or cereal. A package should primarily promote the product, not plastic toys and towels and teddy bears.

4. More tear strips on cartons would ease the housewife's chores, but, where necessary, with provision for closing the carton afterward.

5. More tear strips on cases—if I may digress a little into this evening's panel topic. A tear strip or two strategically placed could save the retailer time, and in a business where the net profit is down to 1% now, every man-hour is important. Tear strips save sliced cartons (a common complaint) and a strip placed near the bottom of a one layer case will enable the stock man to open, stamp, and place the layer on display in one easy motion.

A two-layer case could be divided by a carboard tray that can be easily lifted to permit easy stamping of prices on the bottom layer. A tear strip in the middle of two layer cases would facilitate the stacking of half cases in back rooms.

6. While we are on cases . . . let us be realistic about their total weight. Automation may seem to negate this worry, but it pays to remember that once a pallet of paper products reaches the back room, it must still be stacked by hand. Our clerks eat well, but they are not giants. Try lifting and stacking an awkwardly large case of waxed paper or toilet tissue weighing 40 or 50 lb., and do this in the cramped quarters of a back room and you will appreciate the problem.

7. Do not make cases so large they cannot be handled on regular conveyor belts without being placed with a micrometer. Jam ups in the flow of merchandise cost time, money, and crushed cartons. Bulky cases also clutter aisles when restocking must be done during store hours.

In general, make cases easy to handle!

8. More attention could be given to moistureproofing packages, and at the same time maintaining attractiveness. People want freshness and pourability in everything even soap. For example, have you ever tried to pour lumpy borax into a diaper pail or lumpy sugar into a bowl?

9. Supply carrying cartons for beer bottles, catsup, and other bottled merchandise. Here is an area where you can increase your business, while doing a real service for the retailer. Bottles are difficult to pack, easy to break, and messy to clean up. A carton might also lend itself well to multi-unit sales. Cartons for nonreturnable bottles need not be as sturdy as pop carriers. These bottle carriers should be made in such a way that they can be shelf stacked and displayed attractively and safely.

10. Consider the possibility of unitized inner wraps on soap powders and other products. For example, each cup full of powder could be packaged in a dissolving or disposable envelope. This would save leaking cartons and measuring cups. Some cake mixes could be handily divided into two sealed packages within each carton.

11. Sometimes a smaller carton is better for the consumer than the large, king size, and super giants we are now plagued with (Jiffy cake mix is a good example). They can be sale priced at a dime (usually pre-stamped) and make a family-of-four sized cake. While they do not stack too well, they are excellent for jumble displays and could be shelf stocked in bins à la Jello, if so desired.

12. Do not judge the durability of your carton by the number of complaints you receive. If you multiply these by 10 or 12 you will be closer to the truth.

The grocer who discovers a leaker or an improperly sealed package finds it less trouble to scotch tape and mark down the item than to send a complaint through channels or wait for a salesman. The store manager has 4000 other items to worry about. The customer who gets stuck with a similarly bad carton doesn't usually bother to return it or complain. More often she quietly switches brands.

13. Do not measure the durability of your carton against mere grocery shelf life. Some items may sit in the pantry cupboard for months before use or between uses. Some times the housewife is not as careful of rotation as the grocer, yet she expects the product to be fresh or to pour smoothly at all times. The bottle carrier that has shivered and soaked in a cold, damp basement for months is expected to carry the empties back safely. The consumer is the demanding master of us all. Since this is the case, it is apparent that without exacting and realistic quality control, there soon would be no production problems. There would be no production.

Testing Folding Cartons for Packaging Machine Performance and Testing Filled Packages for End Use

Howard N. Nelson

I HAVE been asked to speak to you today about the problems of the packer and some of the tests used to assure acceptability and runnability of a folding carton. Of course, the ultimate aim is satisfaction in the market place by the customer.

For the purpose of this discussion I would like to focus your attention on two award winning folding cartons. First, the new Kleenex table napkin dispensing package. The judges noted the convenience of the folded napkins contained in the package, which becomes a handy dispenser when broken in the middle. A merit award was given by the Folding Paper Box Association of America to Michigan Carton Co. Kimberly-Clark Corp. for this development. In the second award, the October, 1959, issue of the American Boxmaker referred to a consumer survey made by The Better Package Designers Council and indicated that the Kleenex tissue package was among the ten best in America.

Our past experience showed that variations in folding carton quality occurred between carload lots, causing operating difficulties in the packaging equipment. Several years ago an inspection system for incoming carload lots was set up. At the start of our inspection study, we did not keep separate or identify the cartons by lots as received. All of one vendor's cartons were put in one storage section and issued at random to the sealers. With this system, at times, as many as six or seven different lots were issued to a sealer during a 24-hour period. It was impossible to make adjustments necessary to run so many different lots of cartons.

The first big improvement in sealer delays came when each skid load of empty cartons was identified by a lot number and each lot stored separately and issued to a designated sealer as a unit. This meant that a packaging machine would run 4 to 5 days on the same lot of cartons.

As carload lots of cartons were unloaded, one container of cartons out of every 24 containers was set aside on a special skid. These 24 containers were then run in normal production. Operators selected one carton from each container for laboratory tests. At intervals during the run, a completely sealed carton was taken at random from the final sealing and inspection station for inspection. When the remaining 97% of the carload lot was run during regular operation the sealer operators recorded the number of delays caused by cartons. This figure was then used to correlate operating delays with the physical tests and with the test skid delays. Of the 24 cartons obtained from the test skid, ten were selected at random and tested in the laboratory. A number of significant tests for carton characteristics which affect operation on the sealers were developed. The characteristics which were found to be most significant are: (*a*) amount of force required to open the carton, (*b*) overall carton length, (*c*) degree of scoring of the carton flaps, (*d*) density of the carton board, (*e*) carton board stiffness, and (*f*) strength of the perforation of the tear strip.

An overall quality rating which included the effect of all of these characteristics acting together was developed. The variables measurements for each characteristic were converted to ranks and the ranks totaled for each lot of cartons. The rating obtained in this manner correlated with the number of sealer delays experienced. Twenty-three different tests are made on folding cartons.

Corporation wide, we use a total of 379 testing procedures. Of this number 30 conform to published TAPPI Standards, 8 partly conform, 27 do not conform, for various reasons. The remaining 314 are of Kimberly-Clark design and are not related to any TAPPI testing procedures.

I mentioned selecting ten cartons at random for tests in

HOWARD N. NELSON, Research and Development, Kimberly-Clark Corp. Neenah, Wis.

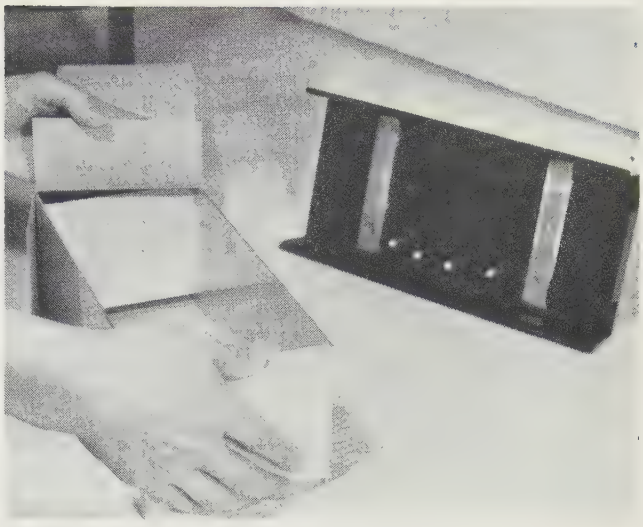


Fig. 1. Placing supporter in folding carton

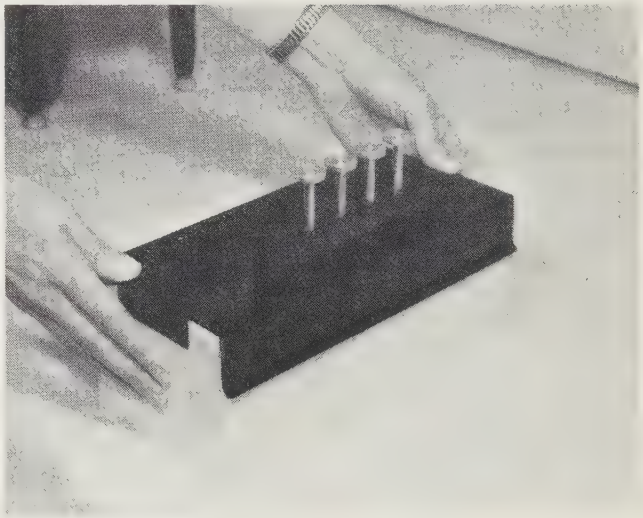


Fig. 2. Assembled folding carton and perforation tester

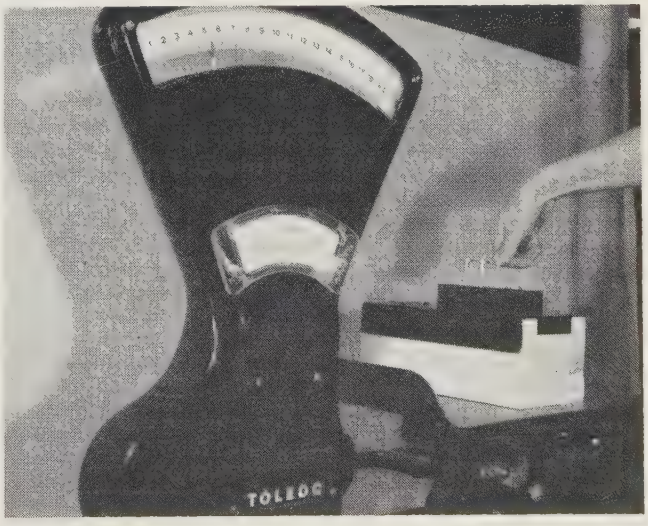


Fig. 3. Reading dial as perforations break

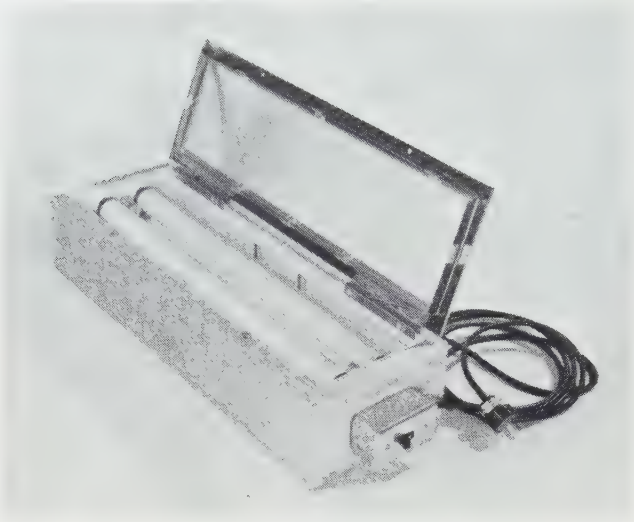


Fig. 4. Light box

the laboratory. The following characteristics were measured on each of the 10 cartons:

1. Warpness.
2. Overall length.
3. Number of asphalt specks on inner liner.
4. Ink ruboff.
5. Degree of flap scoring.
6. Perforation strength.
7. Board smoothness.
8. Board caliper.
9. Board basis weight.
10. Board Mullen strength.
11. Board machine direction stiffness.
12. Board water drop test.
13. Opening force—force required to open carton.
14. Per cent moisture.

What did this inspection system accomplish immediately? Chiefly, it reduced sealer delays by more than 50%. Sealer delays, for us, means rehandling of the product which in turn influences the quality of our product. On a longer range by working with our folding carton vendors, we were also able to reduce the carton opening force required and to decrease the overall length variations.

The inspection system did much to improve the runability of the folding carton in our plants. However, we had not attained a carton that maintained a desired balance of perforation strength along with the important factor of an easy opening for the consumer. This, we set out to correct.

Our folding carton perforations—for gaining entrance to the product—are most important to the functional use of the Kleenex table napkin and the Kleenex tissue package. This is further complicated by the fact that in the Kleenex tissue carton, we are forced to place the tear out strip against, rather than with the grain of the board. We wanted to find simple test methods to maintain a desired balance and level of perforating. The perforation bonds should not break in the normal movement of the package from the carton vendor, through the packer and into the hands of the final consumer who then should be able to open the carton easily along the perforation pattern.

Such test methods were found through the development of a light box and a scale test. A light box is a simple enclosure with uniform light below a frosted glass. By placing a carton on the glass, one can easily determine how well the perforations are cut. The scale test uses a standard scale such as a Toledo scale. A sealed carton is placed on the scale table. By pressing on the perforations, we can easily measure the force required to rupture the bonds which I define as "opening force." This test closely duplicates the force exercised by a customer in opening the package in her home. I will now describe the devices in somewhat more detail. Figure 1 shows two units—one, a supporter placed in the carton and a device to apply pressure to the perforations. In Fig. 2, we show the assembly of the insert form and the punch button case and the carton is ready to determine perforation strength. Figure 3 shows the method employed in watching the dial scale and reading the pounds pressure at the moment perforations breaks for each button.

The light box is shown in Fig. 4. It is a standard house fluorescent unit. We use a recessed fixture to which a wooden box is added. The unit sells for approximately $13. Two fluorescent bulbs with a flat-style white glass panel provide light to easily evaluate cut perforations. We find a 12-in. tube, 2 to 4 in. diameter, such as a paper core, provides an excellent tool through which to view the perforations, as outside light is nearly shut off.

There are a number of instruments used to measure perforated bond tensile strength. In a sudy we made early this year, much variation in results obtained were noted between such instruments as the Instron, Thwing-Albert, Amthor, Rapid Schopper, and Regular Schopper tensile testers. Further, our study showed that with folding cartons stored and tested in 20, 50, and 80% R.H., the "opening force" required to break the bond increased in the higher humidities; but, the tensile strength of the perforated bond decreased.

I believe the scale test and the light box test can provide the carton maker and the packer with a tool that provides quick and correct information to build into the package a well balanced perforated opening leading toward better acceptance of the product in the market place.

In closing, I am very sure, with a close coordination and mutual understanding of each other's problems, a steady flow of top-quality folding cartons can move through plants, as represented by the panel members, onto the shelves of the market place and into our goal—the hands of the consumer.

Panel Discussion

R. N. Campen (Colton Chemical Co., Cleveland, Ohio)—Exactly how does the Vanceometer measure ink receptivity?

I. L. Lester—The Vanceometer rating on board is a measure of the board's foil penetration ability. It is not a direct measure of ink receptivity due to the complications of ink formulas, but it has been determined that a correlation between Vanceometer reading and ink receptivity or ink absorption can be determined.

R. N. Campen—Is it more reliable than K & N Ink receptivity?

I. L. Lester—Vanceometer is more reliable only in that its results can be reported in numbers. K & N inks are still used and many times used in conjunction with Vanceometer to judge a particular board.

R. N. Campen—What is optimum ink receptivity?

I. L. Lester—Optimum ink receptivity varies with practically every job depending on the board used, the printing process used and the complexity of print copy. For a given printing operation the use of the Vanceometer can give a range of numerical values for oil absorption which will correlate with fast press operation. Certainly we do not want a board that is so receptive to ink that it requires excessive amounts to achieve the print appearance desire.

T. Anderson (General Foods Corp., Battle Creek, Mich.)—Is there any merit in considering design on end panels? Especially cereal cartons? I have observed on many store shelves cartons are stored on back panel.

W. W. Adams—Yes, consideration should be given to the marking on end panels. Often times to "tie" the packages (because cereal tends to settle and bulge the cartons) a box or two will be placed flat atop the pile.

H. G. Holbrook (Woodlands Products Division, Owens-Illinois Glass Co., Toledo, Ohio)—Would you suggest for your description of the young children in the "Unbreakable

Turtle" story the substitution of "normal" for "destructive?"

W. W. Adams—This humorous exchange may not be of value to the *Tappi* readers, but I agreed with Mr. Holbrook that normal and destructive are interchangeable when applied to young children.

Edward Bryja (Container Corp. of America, Chicago, Ill.)—Who absorbed excess cost on the order with bad curl (half press speed)? Carton plant or board mill?

R. O. Ragan—I do not know for sure, but I believe that an arrangement was reached with the mill so that we did not absorb all of the lost time. It was very definitely specified on the order to the mill exactly which side was to be wound outside.

H. J. Klauke (Container Corp. of America, Chicago, Ill.)—What do you regard as a minimum Mullen plybond specification for gravure boxboard? Is it not true that the perpendicular forces at work in mullen plybond testing only measure one of the components of the forces present on gravure equipment?

C. G. Eckhart—It is true that the plybond mullen measures only the perpendicular forces necessary to separate the weakest bond in cylinder boxboard. We have established, however, that a relationship exists between this separation force, and the pressures deforming board in the printing nips of gravure equipment. In general, we find the wider the nip the greater the deformation and plybond destruction of board during printing. We would say that a minimum plybond mullen level of 100 lb. per 4 sq. in. sample area is necessary to satisfactorily process gravure boxboard up to 0.030 caliper.

L. J. Ferrari (Post Division, General Foods Corporation, Battle Creek, Mich.)—1. Is it permissible for you to give more information on the scale tester for perforations? 2. What are the four knobs used for? 3. Why an increase in scale values as against decrease in tensile?

H. N. Nelson—"The answer to the first question is—yes. The knob is used to place the thumb on during the testing of the perforation. Using a $^3/_4$-in. diameter knob, the tester can easily "feel" the esact moment the bonds separate. Some perforations snap while others slowly draw apart—depending on the board and humidity conditions. You will note the knobs are spaced about 1 in. apart. We test the entire length of the perforated strip. As the knob is forced downward, we use the highest figure obtained on the dial of the scale.

In answer to your third question, this action takes place, we found in our testing, as the moisture content of the folding carton board is increased. However, as we move from the high humidity conditions, then the opposite trend takes place. We consider it important to give consideration to winter and summer humidity figures when establishng standards for the perforations of the folding cartons.

E. W. Ricketts, (Weyerhaeuser Southern Corp., Charlottee, N. C.)—What is being done to improve the folding quality of Clay-Coated board to prevent "checking" or cracking where solid printing is necessary over creases?

I. L. Lester—Since the characteristics of a clay-coated board are the total of the characteristics of the base board and the coating, work is being done on both. In the case of coatings formulation changes involving the use of plasticizer and variations in the kind and types of binders have done much to reduce the problem of cracking of the coating. It has also been found necessary to modify the structure of the base sheet in order that good bending characteristics of the sheet itself are assured to prevent cracking of the coating.

S. W. Trosset (Diamond National Corp., Middletown, Ohio)—What inking system are you using with the IGT?

I. L. Lester—The IGT uses inking rollers and the ink is metered on to this with a micrometer pipet. Uniform distribution is obtained by running the rollers for a short period before applying the test.

The Customer and Corrugated Box Testing
Introduction to the Corrugated Box Panel

Leo M. Monroe

Progress has been made in the corrugated carton industry, as evidenced by the fact that most users of corrugated have ceased to identify the fiberboard as "cardboard."

The years of testing and research in the science of packaging with corrugated has proved fruitful; to the manufacturer, because he offers a better product to this customer; to the customer because he reaps the optimum benefits from a well designed, manufactured, printed carton.

We shall hear from the panel members of the various stages of manufacturing testing of corrugated through to consumer use. We want to consider the premise that the "means justifies the end," because the effort expended by the industry to upgrade corrugated, with tests that measure additional end use and performance characteristics means a better product for the most important person, the customer.

Basically, we ask the questions? Does a customer *really* care whether his corrugated cartons meet a specification? Does a customer concern himself with price alone? Can he be bothered with all the detail of getting his product out the "backdoor?"

The composite customer, we find, does care about the type and style of carton, and he is concerned about the competitive price, because competition and rising costs forces him to look to the shipping room for *hidden* profits.

Who is a customer? Someone who buys our product? Yes. Someone who determines how we shall manufacture our product? Yes. Someone who is unconcerned with the problems of the corrugated inudstry? Yes. Someone who expects more for his money? Yes. Someone who demands? Yes. Someone who is easily pleased? *No.*

A customer, or a user of corrugated cartons, is one who buys our product to meet a need for his manufactured product, namely, a shipping container, with quality to meet the rigid conditions imposed upon it. Exaggerated, our customer expects and buys a container that should carry his product around the world, by rail, truck, ship, and plane, and arrive at its final destination in a premium condition. So much so that our customers clients can only say nice things about our customer, "goodwill," someone calls this.

In practice, the intangible item "goodwill" can be purchased along with the other assets of a corporation at a nominal cost. Yes, a manufacturing vendor bases all his procedures, methods, testing, research, sales, and thinking around this nebulous term, and on occasions, without sufficient information as to the intended or end use of a product, so that the consumer realizes the optimum benefits with only a negligible amount of the burden included in his cost.

The purpose of end use testing for converters and carton manufacturers, boxmakers, vendors as described, is to produce an improved product, to confront the myriad problems imposed by faster freight handling and shipping, greater tariffs and weights, moisture, humidity, warehousing, stacking and distributing systems, that are empirical to each consumer.

A general purpose corrugated board or container that would yield or conform to the various forces that act upon it would be ideal.

Without such a product, one that would be all things to all consumers, it is vital to the corrugated container industry that new and improved techniques continue to be sought for producing better lining and paper, improving production control test methods, and developing quality control to the highest level.

As these conditions are met, the task of isolating and identifying a satisfied customer is eased.

Leo M. Monroe, President, Leo M. Monroe Co., Cleveland, Ohio.

Mill Testing of Corrugating Medium and Liner for the Fabrication and End Usage

Peter A. Illing

The testing of liner and corrugating medium is the basic means of control used by the paper manufacturer. Any testing program at a paper mill must by necessity be divided into two general categories. Number one is the process control testing. Number two can be termed as referee testing. Number one, briefly defined, is the testing program aiming to keep up with the continuous production pattern of the pulp and paper making process. And number two, the referee testing, is performed according to TAPPI Standards under controlled temperature and humidity conditions. All these tests are performed in order to assure everybody concerned that a uniformly high level of quality is maintained.

The main goal of the pulp and paper maker is the producton of a sufficiently uniform end product from a highly nonuniform raw material, the tree. Even trees of the same species vary in their pulpine characteristics, depending on the type of soil in which they grew, climate, time of year they are harvested whether they grew on the north or the south side of the hill; and we sometimes wonder if the political affiliation of the wood cutter is not also a factor.

In order to achieve this goal process controls must start as far back as the selection of wood species, continuing through the debarking and chipping process.

Even though there exists a significant difference between the manufacturing process of corrugating medium and that of liner, the one being a semichemical pulp, the latter being a true chemical—there are quite a number of similarities in the process control. In both processes the measurement of wood chip size and moisture content as well as the proper control of digester charge play an eminent role. In addition to the chip control, the control of the digestion process is a must for the papermaker. This is accomplished by a partially automated cooking cycle where chemicals, temperature, and retention time are regulated. After disintegrating the wood into pulp fibers, the pulp is washed and refined, where the same degree of control must be exercised to provide a uniform pulp for the paper machines.

While we have discussed the similarities in the control systems for semichemical and chemical pulping processes, it must be understood that there are a number of basic differences between the two processes. The semichemical process, as the name implies, uses only a partial chemical digestion with the remainder of the pulping being done by mechanical means. Practically all corrugating medium is nowadays produced from pulp obtained by this process. The sulfate pulp process, practically always used in the production of liner, on the other hand, represents a true chemical digestion and disintegration of wood into pulp.

I hope that this brief introductory description has given you an indication of the controls applied throughout the process of pulping to assure a uniform pulp quality before the stock reaches the paper machine. Here on the machine, where the sheet is being made, again all control devices are keyed toward the manufacture of an end product with an optimum of uniformity.

Despite the care exercised throughout the manufacturing process, a paper machine produces a sheet with some degree of variation in its physical properties. In order to supply the converter with a continuous quality level, a number of tests can be allowed to leave the manufacturer's plant. These tests are designed to be compatible with the tremendous tonnage produced by a modern paper machine and at the same time assure the manufacturer that a uniform quality level is maintained.

These two requirements necessarily lead to a compromise by adjusting the standard testing methods, with their 24-hour time lag, to the needs for a rapid and still reliable procedure of obtaining test data for the individual grades of paper manufactured.

For the corrugated box makers there are two grades of paper that are of main concern to him: the liner and the medium.

Let me try to give you a brief outline first of the testing procedures used at our Charleston mill for testing liner. In order for the box manufacturer to meet his obligations under rule 41, he must be assured of an adequate mullen and basis weight level. If performance under rule 41 were the only thing the liner board mill had to be concerned with, he would find the testing program indeed a simple one. He is aware, however, that mere rule 41 compliance does not by itself insure a high quality corrugated box and has for this reason imposed certain other restrictions on his procuct. He has adopted and devised tests that attempt to indicate the runability of the material as well as define its appearance and end use performance.

Rather than dwell at length on well-established and standardized TAPPI and ASTM Procedures, I would like to use the alloted time to treat those tests used in process control In most cases, these tests deviate from TAPPI and ASTM Standards in only one respect—that is, the sample is not conditioned in a constant temperature and humidity atmosphere before testing.

The first step in any testing program must be sampling, for without a well designed sampling plan, any data collected will be suspect, if not completely useless. Our sampling program was devised by taking into account the kind of testing to be done, the variability of our product, and the degree of control we wanted to exercise. I won't go into detail about our sampling procedure for it is unique to our own operation and I am sure it differs in many respects from programs that are just as effective in other mills. Now I would like to discuss the individual tests we perform on liner board.

First let us take basis weight. A tremendous volume of samples must be taken to insure that specifications are being met, and a rapid and accurate method of basis weight determination has to be used. We have found a most effective combination in the toledo long-arm basis weight scale and the indexing head square foot sample cutter. These two tools used in conjunction with each other have enabled us to test the large volume of samples necessary to insure the boxmaker that his specifications are being met.

Moisture content of paper can be, and is, measured in many different ways. At Charleston, we elected to use a gravimetric method and use a basis weight scale for weighing, and an Emerson speed drier to dry the sample. Results obtained with this method correlate very closely with the standard TAPPI oven drying procedure and, of course, a determination can be made much quicker.

Let me disgress for a moment here to discuss moisture content of liner and medium as it affects runability of the combiner. If a poll were taken among the corrugator operators in the industry as to what they consider the ideal moisture level in liner or medium, I am sure we would find variations in what is considered optimum moisture. I do think, however, they would all agree that it is moisture variation in a roll that accounts for most of their runability problems. I am talking about the bane of the papermaker and converter —*wet streaks*. Here is where the resistance-type moisture meter comes into its own. While they do not have the degree of accuracy of the gravimetric method, they are much more versatile and are ideal for detecting wet streaks. When used conjunction with the gravimetric method they help the papermaker deliver a more uniform product.

The Mullen test is either the panacea for all of the boxmaker's ills, or a poor measure of nothing—depending with whom you are talking. Any difference of opinion that may exist about how well bursting strength correlates with box performance is academic, however, since it is specified in

Peter A. Illing, West Virginia Pulp & Paper Co., Chicago, Ill.

rule 41. I have no intention of arguing the pros and cons of the Mullen test and will confine my remarks to the care and feeding of the Jumbo Mullen tester and how the test is performed in our plant. The method we use is exactly that prescribed in TAPPI Standards except that the sample is not conditioned before testing.

As for calibration and maintenance of the Mullen tester, we have found that despite its rugged appearance, it requires a certain amount of maintenance and frequent checking to keep it in calibration. Aside from proper calibration, probably the most important factor in obtaining accurate Mullen results, is a constant clamping pressure. For this reason, most Mullen testers are now equipped with a device that regulates the clamping pressure.

Various methods of determining the size level of liner board have been developed and all have their merits and shortcomings. One of the best, and the one we prefer, is the Cobb size test since we feel it more nearly approximates the conditions the board will be subjected to. One of the big advantages of the Cobb test is that it enables you to test each side of the sheet separately. This is important for we must deliver to the boxmaker a sheet that is receptive to the adhesive on one side and still has some resistance against wetting by water on the other, or outer surface.

Scuffing level is another property of the liner that we test for. Here we use the S & S scuff tester and report our result as the number of double strokes required to cause a failure between two liner surfaces as they are rubbed back and forth across each other.

Caliper is measured with a Cady automatic micrometer caliper and is controlled for both variation and level. While caliper is no longer specified for liner in rule 41, it is still an important property of the sheet as far as the box maker is concerned. Uneven caliper can sometime cause a runability problem but an even more serious situation can develop if combined sheets of unequal caliper are fed to a printer slotter. Since most printer slotters are set for the correct impression on the thinnest sheet, all sheets thicker than this are crushed, and I don't have to tell you boxmakers what this does to the flat crush and compression tests.

Several other tests relating to the strength characteristics of the liner are made routinely, although not with the frequency of the ones I have just discussed. These are tear, tensile, stretch, tabor stiffness, ring crush, and folding endurance.

Briefly, I would like to mention those properties of the sheet that affect printability and appearance and how we test for them. In this category we find brightness, Vanceometer, and the overall appearance of the sheet.

For our brightness control, we use an instrument developed by the research people in our own company. This instrument readily lends itself to quick and accurate brightness determinations and reads directly in G.E. brightness units.

We also have a G.E. brightness tester, but use this only as a standard against which we can check out control instruments.

The Vanceometer test, while it does not by itself, predict the printability of a liner board, is of some value in helping control our sheet's surface properties and is used as a routine control test.

The last area I will cover can not properly be called testing in the strictest sense, as it is somewhat subjective and no instruments are involved. It is important, however, because some means must exist to assure the quality of the over all appearance of the sheet. We have set up standard samples, and samples from every roll of liner produced are visually compared against these standards for cleanliness and over all appearance.

For the corrugating medium, these same tests are performed for basis weight, caliper, porosity, and Mullen. In addition to that, we run what is known as the Concora flat crush test. This test has been standardized by TAPPI and there is no need to discuss its mechanical details at this time. Here again, in order to keep up with the rate of production of the paper machine, the papermaker has to reduce the retaining time of the sample in the humidified control test room. Instead of 24 hr., it has been found that average of 20 to 30 min. is sufficient for an approximate standardization of the sample. The test results are reported in lb. per sq. in. Since the Concora flat-crush data serve as a guide in predicting the quality of the finished box, great emphasis has been placed on maintaining an evenly high level. The so-called ring crush test has been discontinued at our Covington mill.

There is one more physical property of the corrugating medium which deserves close observation. This is the previously discussed degree of sizing of the sheet, being essential for predetermining the runability of medium on the corrugator as well as the quality of the finished board.

In extensive comparative test series, we have found, however, that we can deviate from this standard procedure somewhat and still obtain reliable test data. Therefore, the time for humidifying the sample in the control test room has been reduced to 15 to 20 min. and the little 2 by 2 square of medium is set afloat on plain water with the time until the first three wet spots show through, being reported as degree of size.

Last, but not least, I want to explain how we test for moisture content, in the corrugating medium sheet, since this is undoubtedly an extremely important paper characteristic for the boxmaker. As already mentioned, it is not only mandatory to keep a certain moisture level in the paper, but it is of equal importance to maintain this moisture level throughout the cross-direction of the sheet. Corrugating medium stock is what the papermaker calls a "free stock" i.e., the pulp dewaters very fast on the wire of the paper machine and on most machines the time available to distribute the fibers in cross-direction is less than 1 sec. Consequently, the papermaker has to adjust his slice that pours the pulp slurry on the wire, in frequent intervals in order to maintain an even basis weight in the cross-direction. These cross-directional basis weight variations result in pronounced "moisture streaks," as we call them, after the sheet has been dried. In order to detect these moisture streaks, we measure the sheet moisture every 12-in. across the machine width. The instrument used for this is the well-known Hart meter. This is a measuring device that basically originated from what the electricians call a Wheatstone bridge; in other words, it measures the resistance of the sheet, being placed between two conductors. The part of the sheet with a higher moisture content is thus detected by being a better conductor than the part that has a lower moisture content.

Gentlemen, during the past half hour, I have tried to give you a broad outline of the testing procedures used at the paper mill for testing liner and corrugating medium. I have also tried to point out the necessary compromises between the procedures required by TAPPI Standards and the methods which had to be developed by the papermaker for process control testing.

We all are fully aware of the fact that there are still several testing procedures which need further development work. I have no doubt, however, that this goal will be reached eventually due to the close relationship, and by means of good coordination, between paper manufacturers and boxmakers.

End-Use Testing of Corrugated Board and Boxes

Cornelius A. Sullivan

Continental Can Co. has 17 corrugating plants in the United States. Only one of these plants is a two-corrugator operation. The thinking behind this distribution of so many 1-corrugator plants is that the closest possible proximity to the customer makes for lower freight cost and better service.

Since each of these corrugated plants is relatively small,

Cornelius A. Sullivan, General Foreman, Robert Gair Paper Products Div., Continental Can Co., Inc., Cleveland, Ohio.

the inclusion of a conditioned laboratory with the necessarily expensive equipment and trained personnel was considered to be not feasible. One main Quality Control Laboratory was therefore established at the Philadelphia, Pa. plant. Each of the individual plants does, however, have the equipment necessary for making the following tests; Mullen, caliper, flat crush, and pin adhesion. Whenever available, official TAPPI testing methods are used.

The four, above-mentioned tests are performed daily on random selected samples of combinations of the three components of corrugated board. These tests are then consolidated into a monthly report which is forwarded to the laboratory in Philadelphia, where the findings are evaluated.

In addition, a complete set of finished K.D. boxes along with plain corrugated board and unassembled liners and medium from the same run are sent to the Philadelphia Laboratory. Analysis of these samples provides a check on the procedures used at each plant, i.e., how good a corrugating job is being done with the available components and also how the quality of the board is affected by the printing, slotting, creasing, and finishing. In this manner, each plant is afforded a picture of its quality potential that must be maintained. This information is received on reports returned from the laboratory.

From the foregoing, it is evident thatt he functions of the quality control laboratory are:

1. Police the quality of the components used by each plant in fabricating corrugated board.
2. Constantly check the quality standards to be maintained by each Plant.

And now, what is production's part in this picture?

First, a corrugated plant wants liner board and corrugating medium, to have uniformity of all characteristics in order to minimize machine adjustments and waste. This uniformity plus the proper corrugator procedures should make for good corrugated board. But as further insurance newly corrugated board should be calipered periodically at each edge and also as near as possible to the center of the corrugator width. Pin adhesion, flat crush, and Mullen should also be checked, but only after the board has cured. The end scores should also be thoroughly checked for proper folding so that the top-to-bottom compression strength is not adversely affected.

When the blanks are printed, slotted, and creased, the caliper of the board should again be checked, both on the printed and unprinted sections. Some printing may be so extensive that more than just a kiss of the printing die is required in order to achieve good ink coverage. But even in such a case, it is recommended that the impression not exceed seven-thousandths of an inch so that top-to-bottom strength is not reduced. On the unprinted and the lightly printed section of the box, no appreciable difference in caliper should be found in the board before and after printing. The feed roll section of the printer-slotter should be adjusted so that adequate pulling power is exerted on the box blank without producing any appreciable reduction in the caliper of the blank. The body scores inserted by the printer-slotter should allow for proper folding so that the end-to-end compression strength is not adversely affected.

The finishing department should insure an adequate manufacturer's joint, whether taped, glued, or stitched. Here, however, on the semi-automatic machines no formal test has been developed. The inspection is all visual. Boxes that are processed through an automatic machine that slots and scores in addition to taping or gluing should be given a caliper check.

In my opinion the test methods set up by TAPPI are valuable guides to the manufacturers of corrugated items. Some consideration has been given to making tests on actual shipments but so many variables can be encountered on such a test that the data derived may be applicable to only the test itself. Several containers shipped the same way but at different times could conceivably show widely different results. The test methods presently being used are therefore the most reliable yardsticks of quality.

The end result desired from our efforts is a corrugated container of good quality. To sum up, quality must begin at the paper mill. With good quality components, the box plant must then produce the desired result, a container that will not only protect the product but also help sell it.

Some Problems Encountered in the End-Use Testing of Corrugated Boxes

Earl B. Candell

Several years ago I had the privilege and pleasure of speaking to this Lake Erie Section of TAPPI and I am most gratified to be invited back again. My role on the panel is that of end user and your customer, and as such I shall try to develop what we expect to get from you when we place our orders for corrugated boxes.

To those of us who are accountable for the designing and development of shipping containers for our product, is entrusted a considerable responsibility. These containers must protect the product from damage, with the minimum cost for material, labcr of packing, and transportation. The package is generally considered a waste product except as it may serve in market promotion through the printing and display it shows. It is actually an added cost to our customer for it costs him added labor to unpack and dispose of the packing material. We therefore are vitally interested in getting the most efficient package and the best dollar value.

This group certainly does not need to be reminded of the millions of dollars which are spent on corrugated boxes annually, and it is only reasonable that some standards and checks should be placed upon this commodity. But the more we study boxes and the product of our vendors, the more we are amazed at the apparent lack of control in manufacturing boxes. And furthermore, it is astounding that so many users of boxes haven't the faintest idea of what quality and performance they actually are getting. Sure—they know when a box falls apart—or won't fit—that's obvious, but do they know subquality boxes or conversely can they recognize and appreciate extra good quality? Some years ago, when I first started in the packaging activity, our Purchasing Department confronted me with the problem of determining which were good boxes. It didn't take very long to find out that looks could be most deceiving. I was helpless until we set up a simple laboratory wherein we could appraise boxes from the only practical viewpoint—that of performance. And furthermore, I was more astounded to find that after we did have this simple lab, we had more facilities than some of the vendors who were trying to sell us boxes! Does it make sense that the customer knows more about the product he is purchasing than the manufacturer of that product? Yet that is actually true today.

I'm not talking size, Mullen test, nor caliper and weight, but I am talking abut three very important items—combined weight of board, puncture test, and compression strength. These are things that the user must be sure he is getting.

And why are these so important? Well first of all, when we write a specification for a certain basic combined weight of board, we should have first determined that the specified weight board will give the desired qualities, and that it is practical to make. Economically, we strive to get the least weight practical for an increased weight raises the cost of paper and also transportation. Furthermore, uniformity of weight is important because the standard weights used for computing shipping charges of our product are based on these specifications. When we receive board which is 10 to 20% heavier these standard weights are wrong.

Next is that of puncture resistance. One of the great hazards of shipping is that of puncture of the shipping con-

Earl B. Candell, Head, Package Design & Testing Activities, Lamp Division, General Electric Co., Cleveland, Ohio.

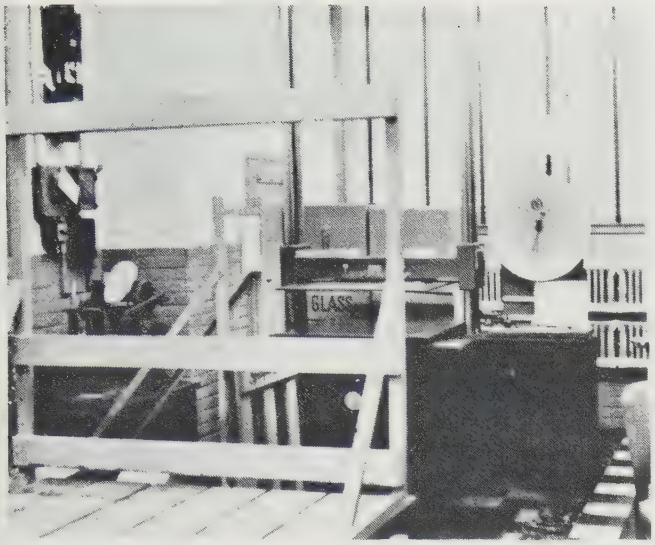


Fig. 1. One end of the testing laboratory showing LAB machine, front center; G.E. puncture tester, left; drop tester, center; compression tester, rear center

tainer causing damage to the product. We therefore wish to keep this value as high as possible without upsetting the other values in the box specification. The value specified is minimum acceptable. There have been many studies made by various people attempting to establish a correlation between Mullen, compression and puncture tests; but as far as I know, none have proved out. However, this does not negate the value of puncture resistance as a desirable factor in product protection.

The compression test is an extremely important value and is becoming even more important now than a few years ago. Extension of the use of fork-lift trucks and palletizing has made possible higher ceiling warehouses with higher stacking of containers. It used to be that boxes were stacked as high as a man could handle them, but those days are gone. Eighteen-foot ceilings are common practice today in the more modern warehouses, so compression strength of boxes is extremely important—yet how many boxmakers know what compression their boxes will withstand? Also, how many users know how much compression they need? One simple rule (which may be argued at length) is that the box must measure in compression four times the weight imposed on the bottom box of the stack. We have found this a very practical minimum figure. This is based on a 50% decrease from ideal due to high humidity and a 50% decrease from ideal due to the effect of fatigue of the board.

There are other factors which certainly need be checked—

Fig. 2. Humidity control panel—right side for room, left side for humidity cabinet

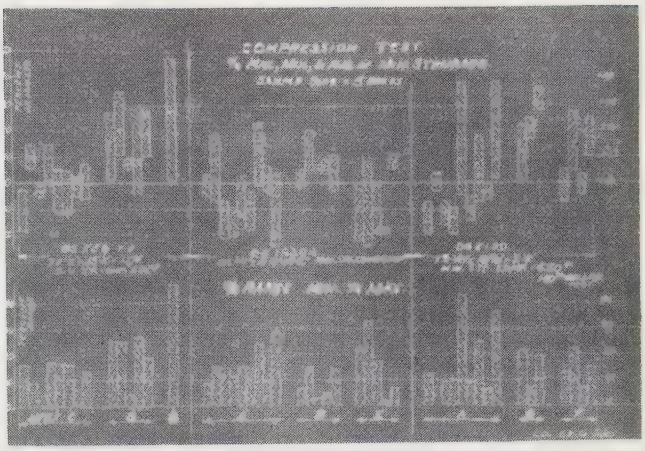


Fig. 3. Compression tests: Upper half—% max., min. and av. of min. standard. Lower half—spread of % variation max. to min.

such as agreement with specs for dimensions, the type of material used, the quality of the scores and fitness for bending, the quality of printing, and absence of signs of crushed corrugations and finger lines.

To digress for a moment, I mentioned that we set up a simple laboratory for testing our packing material. Figure 1 —This consists of a temperature and humidity controlled room which stays at 72°F. and 50% R.H. within the limits given by ASTM Standards. In this is a compression machine which has a recorder that plots the stress deflection curve. The machine compiles with ASTM Standards. In addition we have a Cady tester, a G.E. puncture tester, and a paper scale. These are the basic tools required. We also have a large cabinet in which we can set temperatures and humidities within a wide range. This is used for studying the effects of temperature and humidity changes.

Figure 2 shows the control panel. We use a gold grid electronic control for the room. The instruments to the right are for controlling the room, those on the left are for controlling the humidity cabinet.

I made a statement a few minutes ago that we are amazed at the apparent lack of control of box manufacturers in producing boxes to meet performance standards. That probably rankled some of you box manufacturers, but that statement was based on data which we have assembled over a number of years. Let me show you the compression tests of three sizes of boxes varying from $22^1/_8 \times 15^1/_2 \times 13^1/_4$ in. to $28^3/_8 \times 18^5/_8 \times 9^1/_4$ in., all made from 140 lb. M.T. board. We placed a minimum standard compression of 592, 650, and 676 lb. on these three sizes. The data cover six different manufacturers over the past year and a half. Each bar in the upper half of Fig. 3 represents the lowest and highest value of a sample of five boxes sent in for test. These values are given as per cent of minimum specified. All these vendors were given identical specifications and quoted prices on these specifications. The minimum specification is a value below which we will criticize and can reject. Safe stacking heights are computed from these minimums. The average of the five boxes is shown by the line through the bar. Vendors are coded by letters. On the lower part of the chart, the length of the bar shows the spread in per cent of the sample of five boxes.

Now I'll ask you—what degree of quality control does this represent? Is it good? Is this what we must expect from the industry? Is a spread of 20, 30, or 40% in a sample of five boxes normal? We as users would like these questions answered because it represents dollars out of our pocket for two reasons.

1st—If we must tolerate these low values, then we must upgrade our boxes and this is very costly and wasteful.

2nd—If the higher values have been made, why can't they be made consistently so that we could actually downgrade

our board a little and save money. It is obvious that these vendors who can give us higher values with the least spread, will have preferential treatment.

Another question—would you boxmakers be content to receive your materials with this much variation, or do you?

Please don't get me wrong, I'm not trying to be facetious in this. But here is my problem: we make these studies and send them to our factories who are buying these boxes. These factory men, who are schooled in quality control, have asked me these very question, how am I to answer them? These questions must be answered by the box manufactures first.

If you think this is merely an academic question, lock at Fig. 4. This was taken in one of our warehouses last summer. These boxes are stacked 18 high without pallets. Notice that some boxes on the bottom seem to be holding up well, whereas others even midway in the stack are collapsing.

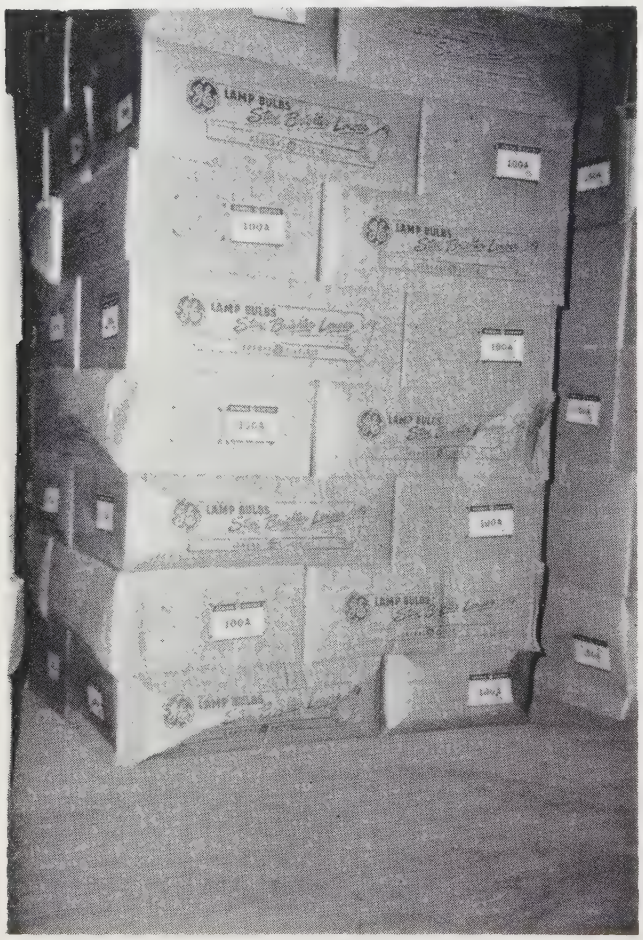


Fig. 4. Stack of boxes in a warehouse

Bear in mind that our product is not expected to sustain a load—it is a fragile article and we have maintained that the outer container must carry the load. Isn't it reasonable to suspect that much of this trouble is due to variability in box strength?

A similar study was made of bulb hampers which run about $21^1/_2 \times 21^1/_2 \times 19^7/_8$ in. We get these in two types of board 275 lb. D.W. and 350 lb. S.W. Here I have found practically the same spread with one added problem.

It is specified in ASTM that before starting to measure deflection, a 50-lb. initial load shall be made. Furthermore, and I can't find an authority for this other than common practice, the maximum compression is read at failure or $^3/_4$-in. deflection, whichever comes first. For the S.W. board, there is no problem because compression failure rarely goes beyond the $^3/_4$-in. deflection; but for D.W. compression, failure usually occurs at greater than $^3/_4$-in. deflection. If we were to increase the initial load from 50 to 80 or 100, then the readings would resemble the S.W. board. It seems to make sense that, because of the greater thickness of the board, a higher initial load is proper for D.W. board—is there an industry standard on this? If not, can't we agree on some value?

Figure 5 is of a chart made some years ago, covering the period March 1951 through November 1953. It is typical of the charts we maintain for the various boxes we sample. On this chart are three of the factors I have been talking about —compression, puncture, and basis weight. Vendors are coded at the bottom—note variations shown on this chart.

TABLE I

ALL BOXES MADE FROM 140# M.T. - S.W. KRAFT CORRUGATED

Mfg'r	COMPRESSION Min.	Max.	Avg.	% of MIN. STD. Min.	Max.	Avg.	SPREAD
BG526-F2 - 22-1/8 x 15-1/2 x 13-1/4				MIN. STD. COMPRESSION = 592#			
C	480	578	522	-18.9	- 2.4	-11.8	16.5
	624	676	648	+ 5.4	+14.2	+ 9.5	8.8
	558	584	572	- 5.7	- 1.3	- 3.4	4.4
	578	680	631	- 2.4	+14.8	+ 6.6	17.2
	522	622	562	-11.8	+ 5.4	- 5.1	17.2
	520	616	584	-12.1	+ 4.1	+ 1.3	16.2
	562	604	584	- 5.1	+ 2.0	+ 1.3	7.1
	556	638	592	- 6.1	+ 7.8	0	13.9
G	598	750	687	+ 1.0	+26.6	+16.0	25.6
	654	800	715	+10.5	+35.1	+20.4	24.6
	624	650	639	+ 5.3	+ 9.8	+ 7.9	4.5
	568	726	646	- 4.1	+22.6	+ 9.1	26.7
	652	764	704	+10.1	+29.0	+18.9	18.9
D	594	876	758	+ 0.3	+47.9	+28.0	47.6
BG1930-A - 25-3/4 x 15-1/4 x 8-1/2				MIN. STD. COMPRESSION = 650#			
A	618	674	653	- 4.9	+ 3.8	+ 0.5	8.7
	606	706	646	- 7.1	+ 8.6	- 0.6	15.7
	510	606	559	-21.6	- 6.8	-14.0	14.8
	516	588	548	-20.6	- 9.4	-15.7	11.2
	568	668	627	-12.6	+ 2.8	- 3.5	15.4
	532	628	605	-18.2	- 3.4	- 6.9	14.8
	644	800	733	- 0.9	+23.1	+12.8	24.0
	632	700	667	- 2.8	+ 7.2	+ 2.6	10.0
	490	674	590	-24.8	+ 3.7	- 9.2	28.5
B	636	684	668	- 2.2	+ 5.2	+ 2.8	7.4
	680	782	739	+ 4.6	+20.3	+13.7	15.7
	680	700	692	+ 4.6	+ 7.2	+ 6.5	2.6
	682	712	695	+ 4.9	+ 9.5	+ 6.9	4.6
	628	722	678	- 3.4	+11.1	+ 4.3	14.5
E	506	650	594	-22.2	0	- 8.6	22.2
	490	710	645	-24.6	+ 9.2	- 0.8	33.8
	530	644	587	-18.5	- 0.9	- 9.7	17.6
	522	534	529	-19.7	-17.8	-18.6	1.9
	686	728	702	+ 5.5	+12.0	+ 8.0	6.5
BG2130 - 28-3/8 x 18-5/8 x 9-1/4				MIN. STD. COMPRESSION = 676#			
A	542	624	574	-19.8	- 7.7	-15.1	12.1
	654	700	670	- 3.3	+ 3.6	+ 0.9	6.9
	566	628	597	-16.3	- 7.1	-11.7	9.2
	542	610	586	-19.8	- 9.8	-13.3	10.0
	644	936	742	- 4.7	+38.5	+ 9.8	43.2
	578	640	613	-14.5	- 5.3	- 9.3	9.2
	626	798	698	- 7.4	+18.1	+ 3.3	25.5
	632	674	656	- 6.5	- 0.3	- 3.0	6.2
	688	938	848	+ 1.8	+38.8	+25.2	37.0
B	678	826	760	+ 0.3	+22.2	+12.4	21.9
	794	844	821	+17.5	+24.8	+21.4	7.3
	790	922	877	+16.8	+36.4	+29.7	19.6
F	626	714	666	- 7.4	+ 5.6	- 1.5	13.0
	714	864	771	+ 5.6	+27.8	+14.1	22.2
	646	698	671	- 4.4	+ 3.3	- 0.7	7.7
	744	846	810	+10.1	+25.2	+19.8	15.1

In my limited time, I could not get into these other variables which show up in our testing, combined weight of board, deflection, etc. In closing, I would like to repeat that we believe most box specifications should include performance values, that box manufacturers should check for performance values and decrease the per cent of variation found between boxes.

I hope you will not think that I have been unduly critical, in this presentation, of you box makers. Certainly you are to be complimented in the strides you have made with corrugated. You have held the line remarkably well with costs, the appearance of the board is good, and it is evident that you are interested in quality improvement or you wouldn't be here today. But, I do believe that these things I have talked about are problems to both the user and manufacturer, and have not been handled as well as they deserve. This seemed like an ideal time to air them and see whether better controls might be established. It is alsmost a corollary that improved controls lead to improved operations.

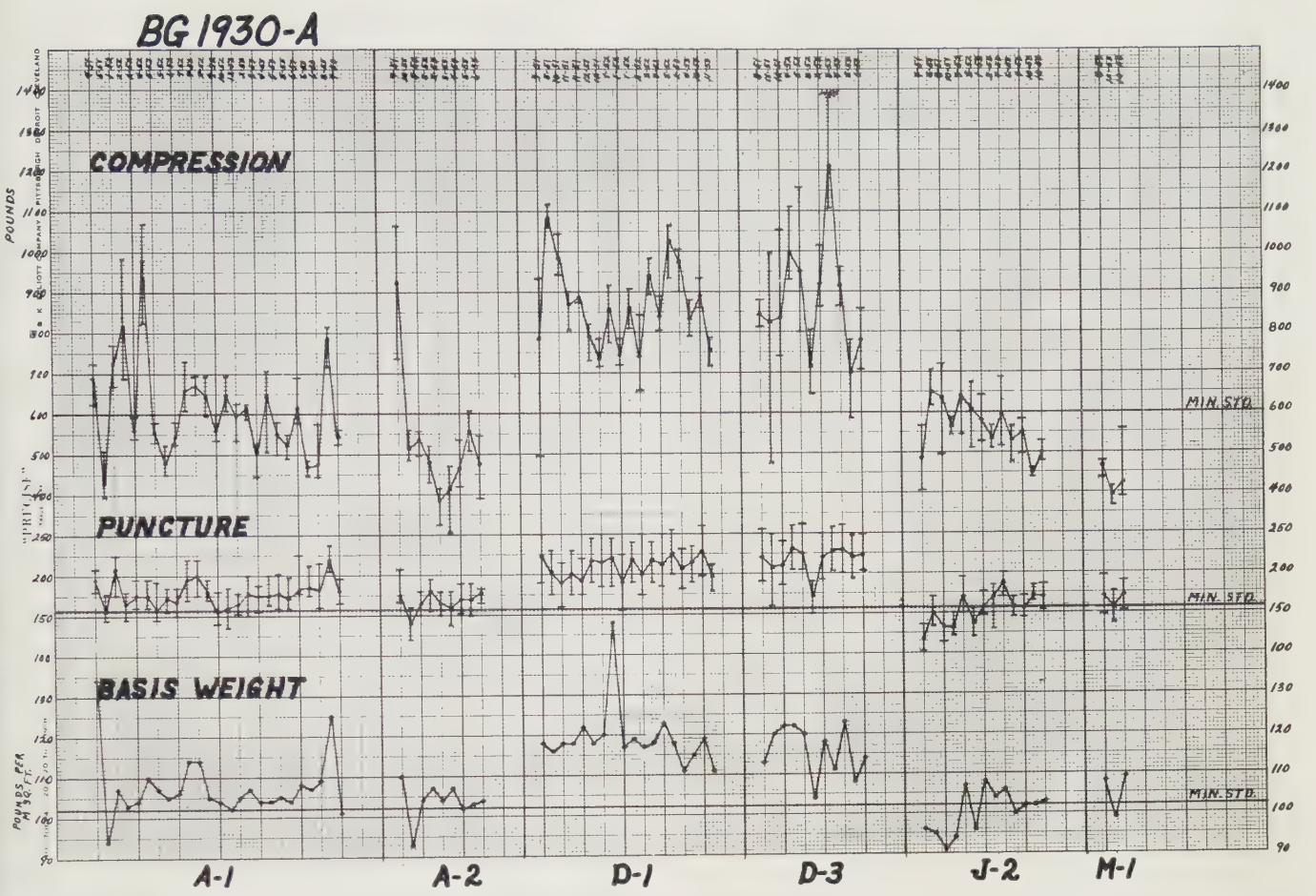


Fig. 5. Chart showing compression, puncture test, and basis weight for various vendors. All tests for box of identical specifications

Most box makers are taking a greater interest in good quality now than ever before. Surely, with this aroused interest, there must be ways of solving these problems.

The Problems We Experience with Corrugated Boxes

Burton Williams

THE opening paper has properly stated that the final evaluation for testing is the monetary profit that will be produced. It is proposed to describe certain conditions under which liberal interpretations of this motive can be harmful as well as pradoxically uneconomical. These conclusions are based on railroad experiences involved with damage prevention activities.

The annual Freight Claim Loss and Damage Prevention bill in recent years has exceeded 100 million dollars, and in 1958 this amount was 114 million dollars. There are many causes to create this large outlay other than this subject being discussed today. Since unlocated damage to freight in packages totaled $46,600,000 there is an indication that packaging can be improved and also that this profit motive is being misapplied.

There are two areas of testing which lead to these situations. The first may be termed design testing—testing for the arrangement of interior packing and packaging for commodities; and two, quality control testing.

An attempt will be made to show that in many instances economic foresight should be utilized before arriving at decisions resulting from either of these two types of testing. In brief, it has been found that immediate profits supposedly available will prove to be more expensive when viewed at long-range.

BURTON WILLIAMS, Chief Engineer, Freight Loading and Container Bureau, Freight Loss and Damage Prevention Section, Association of American Railroads, Chicago, Ill.

First, a description of three experiences to illustrate what is referred to with respect to design testing.

The common procedure for many shippers is to keep records of their damage claims. These records are maintained as percentages of dollar values of units shipped. Whenever the damage exceeds, or is materially under a certain stipulated percentage, laboratory testing programs are instituted. If the damage is excessive the purpose of such testing is to arrive at improvements. When the damage falls below the standard, the intention is to determine where packaging materials or labor may be reduced.

The fact that any testing program is followed is considered beneficial. However, we have mixed feelings as to the practicability of any set standard. How did they know that the standard is right and does it permit a sufficient factor of safety? Also, it is common practice in most instances to have the claims filed by the consignee and under these conditions, generally, the shipper does not have a complete record. Therefore, with programs of this nature being initiated to reduce packaging protection, because the damage is less than previously experienced, it leads to a poor reaction. It is proposed to further elaborate on these features after describing the other two examples.

The second example that may be cited refers to the experiences of a large brewery who reported that they had conducted some exhaustive laboratory tests on the effect of decreasing the height of the interlocking fillers on bottle packages. These tests compared shoulder height fillers with fillers one-half inch less than shoulder height. Their description of the results was that the lower height would save them dollar values reaching into five figures, "without materially increasing the breakage." In other words, immediate material gain was to be the objective even with a prediction that the damage was to be increased.

The third example refers to a proposal by a shipper using multiwall paper bags. This proposal stated that laboratory tests showed that a twoply paper bag, oneply to be of extensible paper, showed as good performance as the fourply bag presently being employed. The point that is disturbing here is the proposal states that the breakage would be approximately the same.

These three examples describe that many shippers expect to have damage. This expectancy conflicts with what should be an overall objective for shippers; namely, to insure that their customers receive commodities that they can use and make a profit on.

The attitude disregards also that the consignees will make an evaluation of different shippers products on the arrival appearance, reflecting pride through application of proper packaging. The customer of the beer shipper will not appreciate the increased number of broken bottles, and the customers of the bag shipper will dislike the annoyances of sweeping up spillage from the bags.

We mentioned a second category of testing standards and referred to it as quality control. One form of such tests could be those included tien the National Safe Transit Procedure. It has been our experience that National Safe Transit has been beneficial in creating packaging and container testing. However, it has been found that many shippers will test the first packages and neglect to follow-through. Other shippers will not have sufficient follow-through checks to give complete control.

Another variation of this quality control procedure involving spot testing, which has been increasing in recent years. Is the substitution of such spot tests to eliminate the number of component part inspections along assembly and fabricating lines. In effect, such spot testing indicates that it is being utilized to replace supervision. It is felt that this process in some instances, which have been observed, indicate that the frequency of spot checking is insufficient to control against damage.

It is understandable that industry finds such labor-saving arrangements necessary to control costs. However, spot-testing programs must be carefully controlled to produce the desired results.

One form of spot checking with respect to containers and packaging in actual transportation has been proposed by some fiber box groups. It is believed that such a program arranged to obtain representative samples of actual conditions would be beneficial. If these tests could develop facts showing packaging weaknesses before many shipments of the item are moved, they would be of great value in reducing recurrent damage.

Essentially then, increases in the damage charges will result in burdens on the overall common fund of all transportation charges. These damage increases thus have to be reflected by additional charges through horizontal rate increases on all commodities.

Therefore, when economic foresight is referred to as being essential in determining packaging changes it is intended to point out that when the new designs produce damages, overall transportation charges are reduced, and with subsequent lower rates shippers enjoy the advantages of increasing their marketing areas. Conversely, when such packaging changes increase the damage costs, the overall marketing areas are reduced. Economic foresight in these instances should insure that the package designs will properly protect the merchandise to insure customer satisfaction as well as to lead to long-range transportation economies.

There are two other points which can be brought to your attention as representative of an industry manufacturing containers used in rail transportation. The first is that the fiberboard containers as compared with wooden crates for furniture, appliances etc., undoubtedly have led to increases in concealed damage. This should not be misconstrued to indicate that these containers cannot provide proper protection, but rather that by virtue of their complete enclosure of the contents, evidence of the damage is not obvious until the final customer opens it. This contrasts with commodities in open crates where damage is often observed before delivery is made to the customer.

The second point is the flexibility of the corrugated fiberboard container as compared with the more rigid containers it has supplanted. This effect is brought out in a paper presented before the American Society of Mechanical Engineers on December 4, in Atlantic City. This paper was prepared by a research director of a freight car equipment company and describes tests involved in development of improving car riding qualities. They describe these tests involving the use of hollow building tile and that with an 8-in travel cushion underframe, breakage was reduced by more than half that of the standard car with conventional draft gears. However, in another series of tests the cushion car and the standard car were loaded with gallons of glass jars packed in fiberboard boxes. Again they reported substantial reduction in coupler forces and accelerations as measured in the cushion car, but damage to the load was extensive in both cars—in fact, two more bottles were broken in the cushion car than in the standard car.

We now quote from this report:

> "Slow-motion movies of the lading action during impact showed that the bottle load possessed a high degree of resilience, whereas the tile load was much more rigid. Although the bottles themselves are rigid, the many intervening carton faces in a car length introduce a large but consistent amount of resilience or springy action in the load.
>
> "Here, then, is a type of lading for which a substantial reduction in coupler force and car acceleration was ineffective in even reducing damage. Unfortunately this test load is a member of the very critical class of lading—goods packed in fiber cartons."

Starting with this premise they developed an improved type of cushioning medium. A complete description is not in order at this time, but it involves a floating center sill arrangement with a 30-in. travel spring controlled cushion. Two additional types of similar cushioning arrangements have been developed by individual railroads. Such developments are new and supply greatly improved cushioning for the lading.

Accompanying improvements in draft gears, car design, and truck riding qualities, there have been increasing demands for lading securing devices to be attached as part of the car. These lading devices in effect compartmentize the contents of the load into a number of units thus reducing the overall effect of the containers resiliency.

Such modern cars equipped with the draft gears, lading devices, controlled ruding trucks, etc., will cost 50% in excess of that of a conventional car. Accompanying such capital cost increases is maintenance increases since such devices are more susceptible to damage and in upkeep requirements.

The source of funds to provide for the described improvements is from the common fund made available by freight charges on the many commodities moving in commerce—products of the mines, agriculture, forests, and industry—such increased costs inevitably result in an increased unit charge for all commodities. Economic shortsightedness, thus, in arriving at reduced packaging protection often disregards demands leading to unessential capital improvements in the freight vehicles, or overlooks customer dissatisfaction in receiving damaged merchandise or placing a damage expectancy on its shipments with an awareness that a recovery will be made under claim payments.

Economic foresight utilized in the design of containers and interior packaging could materially reduce the need for such equipment and higher freight charges. In many instances, the corrugated container industry should also recognize that their containers can more economically supply the cushioning than to have it provided by special cars or devices in the cars. This will also produce a demand for greater use of the ma-

terials you manufacture. The corrugated box industry has made very material contributions to shipping economies. They have also been able to reduce damage in many instances. However, the annual damage bill of the carriers indicates that further reductions can be made.

Testing programs, such as is being discussed in this meeting, can be utilized to bring about these desirable results. We hope, therefore, that we have established a case for the use of economic foresight in the area for such tests and in the subsequent decisions as to packaging changes.

Panel Discussion

QUESTION—"Which plant, the mill or the converting plant would tend to determine the quality of the container?

L. M. MONROE—I think that is the reason for this meeting, the reason for being here. The responsibility to determine the quality of the container should be the burden of both the mill and the converting plant.

You cannot take a series of results procured in a consumer's plant that have to do with, not only the corrugated carton, but also, material handling, transportation moisture and humidity errors and human judgment, and expect these variables to be corrected in a converting plant or a mill without a corresponding instrument control.

We have to analyze these problems and bring our answers to the attention of the mill and the converter.

The business of producing and fabricating board that's going to do a thorough job, that's going to meet all the conditions we've heard in these papers tonight is a big job, and it can be minimized only by having the proper tools to measure end use and performance characteristics.

Granted you can't do something about a problem unless you know it exists but I think an honest effort has been made by the consumer to bring this to the attention of the people who make boxes and to the people who make paper. All the factors that enter into it such as pricing, conditions in a given plant, the present methods we use to test must be considered. "I think it's a bell-ringer, an eye opener, to want to put the onus on both places, in the mill and the converting plant.

QUESTION—How do you test for moisture when making Linerboard?

P. A. ILLING—We use a gravimetric method, i.e, the Toledo basis weight scale in conjunction with an Emerson speed drier. This enables us to keep up with the great volume of material coming off the machine. The Hart moisture meter is a good tool for detecting wet streaks, which is something the boxmaker had to be vey much concerned about.

T. M. COOK (Grace Paper Co., Div. W. R. Grace & Co., New York, N. Y.)—What is the correlation, high and low, to runability of medium on the corrugator?

P. A. ILLING—The porosity, either in Sheffield units or Gurley seconds, is a pretty good indicator for the Concora flat crush test that can be expected from the corrugating medium. Within certain limitations, it also gives an approximate indication about the runability on the corrugator; but there are quite a number of other factors, as we all know, that also play an imminent roll as far as runability is concerned.

T. J. L. HENSON (Thatcher Glass Mfg., Inc., Elmira, N. Y.)—As far as basic weight is concerned, to what pounds do you hold? Do you maintain the same tolerances for 26, 33, 38 and 42 lb.?

P. A. ILLING—We have set up throwout limits for the different basis weights and those limits are kept for every weight that we make, but they are not exactly the same for each weight. The limiting percentages are very small and our operating goals, of course, are closer yet.

T. M. LALOR (St. Regis Paper Co., Pensacola, Fla.)—Is liner basis (weight) determined conditioned 50% in 73°F. for rule 41?

MR. RIDING—Yes, if you mean referee testing. No, if you refer to process control testing. As we all know, a basis weight value is meaningless unless we specify the moisture content of the sheet at the time we took the basis weight. We do make our basis weights conform to rule 41 by making a moisture determination simultaneously with the basis weight measurement. We determine from these two values whether or not the sheet will meet rule 41 standards at the equilibrium moisture the sheet would attain at an atmosphere of 50% R.H. and 73°F.

T. K. ZUCAL (General Electric Co., Nela Park, Cleveland Ohio)—In compression testing, is it possible to make the tests under any moisture content conditions, and then correct it to a standard, say 7½%?

MR. RIDING—I don't think I'm qualified to answer this one on compression. I think you'd better talk to a boxmaker on that. My experience has been at the producing mill rather than in the converting plant so I'd like to beg-off on that one if I may.

MR. SULLIVAN—I'd say no, there is no correlation between extreme conditions where there would be a wide deviation in moisture content.

A. H. MCKINLAY (General Electric Co., Schenectady, N. Y.)—Since scoring is a big factor in variations in compression strength of boxes, is there a good test or a way to specify a good score?

MR. SULLIVAN—A good score is one which will allow a straight line when folded but which will not allow any damage to any one of the three components.

A. H. MCKINLAY—Why all the emphasis lately on heavier corrugating medium? Would it not be better to put this weight in the liners for increased compression strength?

MR. SULLIVAN—Heavier corrugating medium will increase compression strength but it should be remembered that an increase in compression strength can be obtained by using the regular corrugating medium in conjunction with heavier liners. This second method minimizes the need for storing different types of corrugating medium.

E. W. RICKETTS (Weyerhaeuser Southern Corp., Charlotte, N. C.)—Using Container Laboratories, Inc., standards for comparison, how do you account for the higher predictive tests for "end to end" as compared to "top to bottom" for same case?

MR. SULLIVAN—'End-to-end' compression strength on a closed RSC can be greater than "top to bottom" compression strength because of the added strength afforded by the flaps.

MR. SCHOENBERG—You quoted a figure of 0.007-in. printing crush for a large area heavy printing; is this a goal or a maximum you attain? Does this apply to multicolor printing?

MR. SULLIVAN—First of all the 0.007 in. is a goal. The maximum that we must not exceed is 0.010 in. We do attain 0.007 in. on most of our heavy printing and this would apply to multicolor printing. The fact that you have to give solid printing a heavier push on the dye doesn't restrict it to one, two, or three colors, if it is a three-color press.

T. M. COOK, (Grace Paper Co. Div., W. R. Grace Co., New York, N. Y.)—Where is the property of the medium most closely watched? And what property on medium is most frequently found to fall below the standards?

MR. SULLIVAN—The property of the medium that we most want is again the uniformity in the moisture content, because we can then adjust our corrugator to the point where it will corrugate one moisture content, but if there is any variation from the moisture content on which we set the corrugator, then additional adjustments must be made on the corrugator.

QUESTION—How do you determine appropriate tests to run on individual lamp packages? Are they significant?

E. B. CANDELL—I'm a little bit confused on the phrase "appropriate tests." I've been describing a box performance test here (in my paper) which is applied to the box without

the product in it. Is the question just on the container, or with the product in it?

Answer—Just on the container.

E. B. Candell—Since, generally speaking, none of our product can support a load and does not lend support to the package, we decided upon a compression test as a means of determining safe stacking heights. Barring subnormal values, such as I have shown in some of the tests, warehouse stocks are in good shape if these boxes meet the minimum standard, therefore the compression test is a significant test. The puncture test is one to indicate toughness of board to impact—this is a normal shipping hazard. Probably one test of its significance lies in our very low damage allowance. This has been a negligible amount.

Question—How do you account for rather uniform results in two tests in the last slide and wide deviation in another test? Note: Z-1 Supplied Boxes.

E. B. Candell—That's what we would like to find out. That's exactly our problem. Why is it that one boxmaker's boxes will have greater uniformity than another. Also, that for the same boxmaker there can be such wide ranges. One of these shown was very acceptable, whereas another was unacceptable, and yet we write but one specification which is given to all. Our policy is for the purchasing dept. to make general contracts and then the various lamp plants place their orders on boxmakers within their immediate area if possible. Obviously this saves on transportation costs. So, one of our problems is to get better uniformity among and within boxmakers throughout the country. I believe one of the big factors in this is the scoring. As far as I can find out, there are no good standards on scoring. We have had a discussion here tonight on scoring. There was not complete agreement—there are conflicting ideas on scoring, and yet I think this is a very important factor if we are to have greater uniformity of compression tests. Scoring is a variable between boxmakers.

R. O. Ragan (Chicago Carton Co., Chicago, Ill.)—What percentage of railroad damage is due to improper "humping" caused by the railroads: when switching, to high speeds, poor railroad cars, and roadbeds that are not maintained as they should be, etc?

B. Williams—It's all there, he's almost answered it himself. Those conditions do contribute to the total. The 1958 Loss & Damage Statement shows 3.4% attributable to the account of improper handling in trains, yards, or stations; 4.1% for defective or unfit equipment; 0.9% for temperature failures; 2.6% for delay; 7.3% for train accidents, and 0.6% error of employee.

J. J. White (Fisher Body Division, General Motor Corp., Cleveland, Ohio)—Since most of us are in the business to make money, doesn't it seem reasonable that the carriers' remedy for bringing up packaging materials lies in revision or amendment to rule 41?

B. Williams—I would think that it's very pointed. I think the standard should be increased. However, we have some competition which doesn't have as complete a standard. The highway classification isn't as extensive as the railroad classification. We also have a problem today where many industries, possibly including yours, are private haulers of over-the-road freight. You also have many private industries engaging the services of contract carriers. Neither the contract nor the private carriers have any packaging specifications whatsoever. However, this is a problem of rates and it does not come in the province of our particular section; but I would think that the policy lies somewheres along the lines which have been commented on.

J. J. White—With all of the new containers coming on the market, such as plastic, etc., would it not be better to have a simple performance test, shock, and vibration for items rather than volume of rules and package numbers as now appears in the freight classification.

B. Williams—Yes, I think that would be a constructive move too. However, we have quite a problem when we set up any packaging specifications, because of the great variety of values in the commodities in that same listing. Furniture, for instance, where there is a considerable variation in the value of the same article. All of these may be fragile and obviously if you set your standards on the most expensive types you are going to penalize the cheaper ones. Therefore, if the latter shippers have to live up to your specifications they have a considerable economic problem. Again, this is a problem handled by the rate committees rather than by ourselves.

Question—Since the railroads approve of National Safe Transit, when are they going to contribute to the claim reduction activity?

B. Williams—You mean by that they assume a claim reduction activity of NST?

Answer—Yes.

B. Williams—I wouldn't know what the problem would be in that connection, and I'm not sure how that contribution would be needed. We have always felt that it is the shipper's responsibility to properly package the merchandise, and I think that is the attitude which the carriers have probably been taking on that particular subject.

J. J. White—What is the damage cost of corrugated package products shipped via trucks as compared to railroads, also, compared to air freight and boats?

B. Williams—I don't know about the air freight and the boat. I do know that the railroad claim ratio in 1958 was $1.34 per $100, and that the truck ratio was approximately six to eight cents less. I do not know what the truck breakdown corrugated would be, but it is not believed that they segregated those types of containers.

L. M. Monroe—I certainly want to take this opportunity to thank all that are here tonight and thank especially the members of this panel. It's been my extreme pleasure to moderate such a group. I am indebted to them for their fine response to the questions, and I know there was no effort made to hedge. I want to say thank you, gentlemen, and if there are no other questions from the floor, then I would like to turn this meeting back to Mr. Boynton.

EMPLOYMENT SERVICE

The rates per issue for Positions Open advertisements in *Tappi* are as follows:

Per line	$ 3
1/16-page Box	$ 50
1/8-page Box	$ 80
1/4-page Box	$125

Positions Wanted

E498–60. Maintenance Workshops Supt., 40 years old, British subject, married with four children. 24 years shop experience, Indentured Apprentice, member of American Welding Society, associate member Institute of Welding, City and Guilds Certificate. 14 years Latin America, full charge machine shops, plate shop, smithy, etc. Trouble shooter, write and speak fluent Spanish. Present location Latin America. Salary and bonus run $7800.00 plus paid vacations United Kingdom. Housing. Desires change. Open for negotiation.

MISCELLANEOUS

A31–60. *Wanted.* A second-hand papermaking and servicing mill with a capacity of 18 tons of packing, wrapping or writing paper per day. The unit offered should be in excellent working condition. Please also quote for a used pulping unit, same capacity, if available. Contact The Paper Products, Ltd., 120 Dinshaw Vachha Road, Post Box 732, Bombay-1, with full particulars, plans and price in the first instance.

POSITIONS OPEN

P1000–70. PAPER CHEMICALS EXPANSION opens opportunities to CHEMISTS and TECHNICAL SALES REPRESENTATIVES. Chemists sought now have positive record of accomplishment in sizes, coatings, furnish formulations, biologicals. We look for top Tech Reps to carry high quality, economical chemicals to the paper industry. Résumé held in strictest confidence. WICA CHEMICALS, INCORPORATED, BOX 506, CHARLOTTE 1, N. C.

Process Control Engineer

An established paper company in the East with expanding manufacturing facilities presents an excellent job opportunity for a chemical, mechanical or electrical engineer interested in developing in the field of process control.

Position demands personable, tactful, individual with willingness to progress. Assignments relate to test, raw material evaluation, process and product improvement. Kindly submit résumé and salary requirements. Reply to P1001-60, ***Tappi***, 360 Lexington Ave., New York 17, N. Y.

WANTED
Southern Representative

Long established, well advertised machine clothing manufacturer needs sales and service representation in Texas, Louisiana, Mississippi, Arkansas area. Prefer man with experience selling to paper industry. All expenses, salary and bonus. Many leads furnished. Send résumé, photo and salary required. Our people know of this ad. Your reply will be held in strict confidence. Write today to P1003-60, ***Tappi***, 360 Lexington Ave., New York 17, N. Y.

REQUIRED IMMEDIATELY

For

New Kraft Pulp Mill in British Columbia

PULPING GROUP LEADERS, MACHINE TENDERS, COOKS, BLEACHERY OPERATORS, TRADE GROUP LEADERS AND OPERATORS FOR EVAPORATORS, RECAUSTICIZING, BROWN STOCK, KILN, AND ALSO BLEACHERY ASSISTANTS, DIGESTER ASSISTANTS, LAB ASSISTANTS, BALERMEN AND TRADESMEN

Applications are now being accepted to fill the above key positions in Celgar Limited's 500-ton bleached kraft pulp mill under construction at Castlegar, B.C.

Here is an unusual opportunity to work with a progressive organization from start-up. Celgar is a well-established Company offering attractive job opportunities and welfare plans in one of Canada's finest residential locations.

Moving and housing assistance will be provided.

Fully experienced pulp mill personnel interested in advancement are invited to submit a confidential detailed letter of application to:

CELGAR LIMITED

PULP MILL DIVISION
BOX 1000
CASTLEGAR, B.C.

V 5929-3

SALES ENGINEER

Unusually fine opportunity for a technically qualified salesman who has sold to paper mills or who has had paper mill experience.

The man selected for this position must be able to apply his knowledge of paper making and coating to the sale of specialty starches for all such applications.

The position holds excellent promise for advancement with a progressive company in an expanding program.

Salary open—based on experience and education.

Your inquiry with full résumé will receive immediate confidential attention. Reply to **P959-60, Tappi, 360 Lexington Ave., New York 17, N. Y.**

PAPER CHEMISTS

For challenging position in Paper Development Group of one of the leading suppliers to the paper and corrugating industries. Position involves development of natural and synthetic coatings, sizing agents, binders and technical service work to customers.

B.S. or M.S. chemist with some paper experience necessary.

Ground floor opportunity in research program that has quadrupled since 1956. New 138 lab unit research center to be occupied in late 1960. Opportunity for advancement into senior or administrative research positions, market development or technical sales.

Please write or call G. M. Prust.

A. E. STALEY MANUFACTURING COMPANY
DECATUR, ILLINOIS **(P995-50)**

APPLICATION RESEARCH CHEMIST

Career opportunity with Fome-Cor Corporation, an associate of Monsanto Chemical Company and St. Regis Paper Company, producing a variety of polystyrene foam and paper laminates.

Prefer a man with background or experience in paper and surface coatings technology, particularly in the application of coatings to paper. Responsibilities will include both laboratory and customer field service assignments.

Requirements: B.S. degree in Chemistry or Chemical Engineer.
0–10 years experience
exempt from military obligations
imagination, initiative and ability to undertake a wide variety of assignments

Please write fully and in confidence to:
Mr. R. G. Fordyce, Director, Research and Development Corporation

FOMECOR

Springfield 2, Mass.

RESEARCH AND DEVELOPMENT

Excellent opportunity with leading electrical insulation and plastics company. New and modern research laboratory and company growth plan create the need for expanding our Research and Development operations and staffing it with creative men who carry can on independent research.

Position available for research chemist or engineer in development of electrical insulating tapes and flexible insulation. Prefer graduate level or equivalent in experience.

Send resume to:

Employee Relations Department
Continental-Diamond Fibre Corporation
A Subsidiary of The Budd Company
70 South Chapel Street
Newark, Delaware

(P1004-60)

Papers Presented at the Corrugated Containers Sessions, and Discussion

45th Annual Meeting of the Technical Association of the Pulp and Paper Industry

FEBRUARY 22–25, 1960

Supervisory Practices in Container Plants

R. W. BUTTERY

It is generally conceded that a foreman is a key man in any manufacturing plant. This is certainly true in corrugated container plants. To the people in the factory he is the company and to the rest of management he represents the factory. He is the man they depend upon to keep them in touch with what is going on in the plant from day to day.

Loyal, intelligent, hard working foremen who can get and keep the respect of the workmen are not easily acquired but without a few of them a smooth running profitable operation is almost impossible.

It therefore becomes important not only that management make the best possible use of these men but also that their working conditions, responsibilities and authority be such that they can do their job well and get satisfaction from it.

With some of these thoughts in mind the Production Committee of the Corrugated Container Division of TAPPI decided to conduct a study of this subject. Such a study should cover how supervisory personnel function in box plants, their responsibilities, their authority, their remuneration, and any other conditions that seem relevant. The information could then be made useful to the industry if properly summarized and analyzed. It would give management some idea of average conditions to use as a bench mark for comparing its own conditions and policies.

A subcommittee of three was formed, A. C. Reid of Pembroke Shook Mills, Doug Adams of Canton Corrugated, and myself to work on this project.

Over a period of eighteen months three questionnaires were sent to 19 plants scattered over the United States and Canada. These varied in productive volume from 72 million to 11 million square feet per month. This seemed a reasonably fair cross section of container plants in these two countries.

In designing the questionnaire it was first necessary to establish certain classifications of supervisors and define each specifically, so that the person supplying the answers could accurately classify his particular supervisors. These classifications were as follows:

Grade 1—A worker who has some responsibility for the output and quality of others.....Lead hand

Grade 2—A worker who spends more of his time supervising others than on direct production work.....Foreman

Grade 3—A man who spends all of his time supervising others but does not have the right to recommend hiring and firing.....Foreman

Grade 4—Same as Grade 3 but with the right to recommend hiring and firing.....Foreman

Grade 5—A man who supervises more than one of Grade 2, 3, or 4.....Assistant Superintendent or Superintendent

Grade 6—A man who supervises one or more of Grade 5.....Same as above

Other pertinent information asked:

1. Manufacturing floor area.
2. Average square feet of corrugated board produced per month in 1957.
3. Average number of order items processed per month in 1957.

Note—Order item is a term used to indicate one item of an order. It would also represent one slitter or cutoff knife change. A container with a liner and partitions would constitute three order items.

Summary of the information obtained and comments.

Number of supervisors reported	308
Number of lead hands	39
Number of foremen	215
Number of superintendents or assistants	54

Lead hands evidently are not extensively used since, of the plants reporting: seven plants used none and five plants used one each. One particular plant used 11 lead hands which was a rather unusual condition.

The average ratio of superintendents or assistants to other grades was about 1 to 5.

Production (millions of sq. ft.) per month, per supervisor: lowest, 1.4; highest, 4.1; average, 2.6.

Production per month per foreman: lowest, 2.1; highest, 6.4; average, 3.7.

Note—The two plants at the extreme opposite ends in the above comparisons are of about the same size and production but the one with highest production per foreman processes only about half as many order items per month as the other.

Order items per month per supervisor: lowest, 51; highest, 214; average, 102. Assuming a 20 working day month this average represents five order items per day per foreman. The 214 figure was unusually high, the next highest being 154.

Manufacturing Floor Area Per Foreman. Excluding roll-stock space and office space, the lowest was 4700, the highest 32,000, and the average 11,870 sq. ft.

In these comparisons the lowest and highest were both extreme cases; all other plants fell between 7,000 and 18,000 sq. ft. per foreman.

Remuneration—Gross Monthly Earnings. This information was obtained on a check chart in increments of $25 for each of the six grades. Low, high, and average is shown for each grade and the number of plants reporting this grade.

	Number of plants	*Low*	*High*	*Average*
Grade 1	12	300	500	397
Grade 2	6	300	550	402
Grade 3	11	350	575	458
Grade 4	16	400	775	535
Grade 5	18	525	875	653
Grade 6	14	700	875 plus	850 plus

Hours of Work and Overtime. Normal hours for supervisors: five plants answered—plant hours. Other plants ranged between 40 and 50 hr. per week—average 43.7. Six plants re-

R. W. Buttery, Director of Manufacturing, Bathurst Containers, Ltd., Montreal, Que.

cord hours worked by supervisors; 10 plants make no record of supervisors' hours; seven plants pay overtime to supervisors. Four of these seven pay supervisors on an hourly basis. Nine plants out of 16, replying, do not pay overtime to supervisors.

Out of 16 replies eight plants have a firm policy to make sure that a supervisor is paid more than any of his men. The other eight plants have no such policy.

Cost of Supervision. Cost of all supervision (excluding lead hands) was reported in relation to the sales dollar as follows; twelve plants reporting: lowest, 0.68; highest, 2.26; average, 1.38 cents.

There is some room for error in these figures since systems of accounting vary to a considerable degree and the sales dollar figure used might vary as a result.

Incentive Pay. An effort was made to discover whether an incentive pay system to workmen had any bearing on the number of supervisors used or the cost of supervision.

Out of 19 plants reporting: 13 paid incentive to workmen, 6 did not; 5 paid incentive to supervisors, 14 did not; 3 paid incentive to other salaried people, 16 did not.

No significant relationship could be detected between the use of incentive pay and the number or cost of supervision. Three comments can be made but should not be considered significant since they concern single cases.

1. Lowest cost of supervision, 0.68 cents out of the sales dollar, occurred in a plant where incentive was paid to workmen, supervisors, and other salaried groups.
2. The highest monthly production per supervisor, 4.1 million square feet, occurred in a plant with no incentive pay.
3. The highest cost of supervision, 2.6 cents out of the sales dollar, occurred in a plant having incentive pay for workmen only.

Superintendents' Responsibilities. In three plants, only supervisors report to superintendent. In 16 plants other staff such as planners, time keepers, time study people, quality control, report to the superintendent; the number varying from one to eight—average, four.

Use of Supervisors on Second and Third Shifts. Of 19 plants reporting, 12 are on 3-shift basis, 7 on 2-shift basis. Of the twelve 3-shift plants, 8 use grade 5 or 6 on the 2nd shift, and 4 use grade 5 or 6 on the 3rd shift. Of the seven 2-shift plants, 2 use grade 5 or 6 on the 2nd shift. The 12 3-shift plants average 8 foremen on the day shift, 4 foremen on the 2nd shift, and 2.5 foremen on the 3rd shift. The 7 2-shift plants average 4.5 foremen on the day shift, and 2 foremen on the 2nd shift.

Note—These figures should be considered while keeping in mind that many afternoon and night shifts are not complete operations and this condition of reduced supervision on the 2nd and 3rd shifts is perhaps not as bad as it would seem. Only one plant reported equal supervision on all shifts. One three-shift operation had no supervision on the 3rd shift.

Seven plants had 2nd or 3rd shifts with only one foreman in charge.

Crew Sizes. Number of workmen reporting to a single foreman: lowest, 3; highest, 57.

In roll stock, shipping, and maintenance the lowest was 3, highest 14, and average 8.

In the production departments—printer slotter, finishing, etc., the lowest was 12, highest 57, and average 25.

Selection of Workmen. In four plants the foremen select their own men, while in 15 plants the foremen *do not* select their own men.

Personnel Problem. In 14 plants the foremen *do* handle personnel problems, while in 5 plants the foremen *do not* handle personnel problems.

Supervisor Training. Of 19 plants reporting, 7 have no training program; 12 *have* training of some sort—11 paid for by the company, and in 1 the cost is shared by the foremen being trained. In nine plants instruction is given by company people during working hours; two plants provide for evening classes in outside educational institutions, and one plant gives evening instruction at the plant by company people.

Six out of 19 companies have a policy of hiring and training supervisors in advance. Seven companies use a system of moving foremen from one department to another for purposes of training.

Supervisors Meetings. This information was difficult to summarize but nine plants held short daily meetings, mostly for the purpose of expediting delivery of orders. Six plants held weekly meetings of from 1 to 2 hr. to discuss quality, waste, safety, and general production problems. A few plants held such meetings every 2 weeks. Monthly meetings of 2 to 3 hr., in some cases dinner meetings, are held by 13 plants to discuss costs, waste, equipment requirements, longer term production policies, union contracts and in several cases for training purposes.

At most daily and weekly meetings the plant superintendent is chairman. At the longer monthly meetings sometimes the plant manager is chairman and in a few cases the general manager takes charge of the meeting. Meetings held for a specific purpose such as safety, fire prevention, or union contract discussions are usually chaired by the personnel director or some other person qualified to discuss a specific subject.

Received March 21, 1960. Presented at the 45th Annual Meeting (Corrugated Containers I) of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Unitizing of Corrugated Containers*

JOHN A. COMLY

The large increase in the unitizing of corrugated containers is bringing about a vast change in plant layouts, methods, bundling, storage, and shipping concepts. Unitizing has increased expenditures for equipment and materials to accomplish its purpose. It has decreased by 15–25% the volume per outgoing shipment. However, with proper understanding and training on the part of all company personnel, unitizing will pay for itself, but only if the desire and initiative are there. It will do this by providing better services to customer; helping to increase production (both real and potential); and helping to lower costs by speeding up the finishing lines and doubling or tripling floor space use; decreasing loading and unloading time and thereby increasing the number of trips per driver per day.

The unitizing of corrugated containers is a very simple process. In keeping with our program theme, "The Production Merry-Go-Round," I want to take a few minutes to describe how simply and economically the end can be achieved.

Let's take the case of George. George is one of the company's leading young salesmen. He has done a tremendous job in developing accounts. He is very particular as to the quality and service given to his customers. On the other hand, George knows something about production and this is always a big help.

Here comes George! He has just returned from the "ABC" Co. and it looks as though he may have made that sale. Let's follow him for a while. Right to the sales department to talk it over with the manager. Everything is discussed; price, quantity, test, printing, quality, delivery date, etc. Yes Sir, nothing left to the imagination. That was a fine job by George, and by George, he deserves the congratulations of the manager. Next stop is the design department. George wants to go over the specs with Jim and make sure

John A. Comly, Plant Manager, Connelly Containers, Inc., Bala Cynwyd, Pa.
* Figures of the slides that illustrated this speech are not included.

everything is right. Next is the quality control laboratory. There's nothing going to be left to chance here. George wants good quality, so let's make sure the inspectors keep their eyes on this one. Let's pay particular attention to the printing. The first order will have to be taped, then we will glue them. O. K., I guess that does it.

George is already to leave but he stops in to see if the manager has anything for him. There are no specific instructions; but something seems to bother him. Oh yes, it almost slipped his mind. The customer wants that order unitized or palletized or baled, or you know, put some of that banding wire around the bundles so the customer can unload it easily.

The order goes through smoothly. It is unitized, loaded, and delivered. But, ABC's receiver can't handle it with his hand fork jack. Sorry driver . . . take it back. There's the first brass ring on the Merry-Go-Round. A quick call to the supplier will iron this out. What the receiver really wants is something with legs in it. One day, 100 miles, and quite a few man-hours later, the receiver at ABC Co. gets his unit with legs in it. The only trouble is they are in the middle of the unit instead of under it. So, we collect our second brass ring. This time he explains to the driver just what he wants. The third try is a huge success and everyone is happy, except, of course, the production man who had to do the re-work, re-shipping and last but not least, had to use customer X's wooden pallets for ABC and then ran short of X's pallets for their order the following day. Incidentally, that load represented only 60% of the volume of the trailer. So much for the birth of a unitized load.

BRIEF HISTORY

I think it is safe to say that unitizing got its impetus from the handling programs set up during World War II. I recall the first unitized orders that went through the plant where I was working were for a government agency. The agency supplied wooden pallets and loaned its forklift trucks to handle the many carload shipments involved. It was a trickly process, but it was a beginning.

Gradually, some of the large customers, particularly those with bulk products, demanded that their shipments be palletized for convenience in handling in their plants. I say "palletized" because a wooden pallet was used under the load. Since then, more and more customers have wanted their shipments unitized. In many cases we, as suppliers, are trying to sell unitized loads because it makes for easier handling, convenience in storage, a doubling or tripling of floor space and the realization of a reduction in shipping time. It also allows service to customers not before practicable.

DEFINITION OF TERMS

Now that we are engaged in unitizing of corrugated containers, let's define the terms that will be used.

Unitized—Any shipment in which bundles, etc., are tiered in a specific manner and generally held in place by steel strapping to allow for unit handling without regard to whether the unit rests on any kind of wooden platform or has legs under it or placed between tiers.

Pallet—A wooden or corrugated platform of about 4 in. height to allow for the entry of forks, hand or electric fork jacks. It may be either two- or four-way entry.

Skid—A wooden or metal platform supported by legs or runners and generally not less than 7 in. in height to allow entry of the older type of hand jack.

Frame—Also may be referred to as a *flimsy*—a wooden frame of light lumber used either on top, and/or bottom of units to keep containers flat and from being distorted by strapping wire.

Legs—Any built-up block, spiral-wound tube, or wooden plug used generally to separate tiers in a unit to allow fork entry.

Banding Equipment

Hand—Any equipment which requires complete manual operation.

Automatic—Any equipment which affords compression, prefeeding of strapping wire, tensioning and sealing with push-button control by operator.

Conveyor Trailer—Any trailer equipped with roller conveyors either permanent or otherwise.

Flat Bed—Any trailer without a body.

Protectors—Any corrugated material used for protection under strapping wire.

Specialty Pallet—Any specially constructed pallet designed for a specific job and generally not in conformance with those normally used. The Government seems to be the main recipient of these types.

SALES DEPARTMENT PARTICIPATION

So far we have picked off a couple of brass rings on the "Merry-Go-Round." Now, what can be done to help get all the right information to the plant. It is of increasing importance that unitizing be given a more important place on the salesman's agenda.

I would like to recommend that the salesman be given a check-off list of questions to be answered concerning unitizing while at the customer's plant, or it can be left for the customer to fill in and return by mail. Such a list would cover items as:

1. Equipment characteristics
2. Unloading facilities
3. Aisle and head-room dimensions
4. Truck or car shipments
5. Pallets or frames
6. Bundles to be tied

It may be advisable to have a direct visit to the customer by a production man so that he may best help service the account as well as his own company.

Once all the pertinent information has been gathered, it is necessary to transmit it to the plant. I would like to suggest a system that has operated with an absolute minimum of confusion for our company for over 3 years. Allow me to describe it: The sales service man has an instruction sheet which shows and/or explains to him how to determine:

1. The overall length and width of completed box, folder, etc., to be unitized.

2. The tier pattern, bearing in mind whether it is car or truck shipment. The instructions cover the characteristics desirable in both cases.

3. The number per bundle—as this controls the number of tiers and the final height and count of the unit.

4. The number of bands and places of identification.

5. Whether a customer's pallet and/or frame is to be used.

6. Placement of legs when required.

Having determined all the necessary facts, the sales service man transfers this information to the production or flow card. Everytime the order is repeated the unitizing instructions will remain the same. This information will contain some or all of the following:

1. Bundling instructions—25 followed by a (T) in parentheses means it must be tied. If tying is not required that (T) is omitted.

2. (Cust) designates a customer's pallet to be used.

3. "A" describes the tier pattern.

4. Leg 8 says to form 1 tier, place legs as required, then 8 more tiers of containers. If legs are not required then "leg" is omitted and total number of tiers put in.

5. "4" indicates the number of bands required.

6. "X" indicates the four bands are to be put on, 2 each way. If bands are to go in one direction only, the "X" is omitted.

7. "2" means there are to be two identifications, one on each side or end.

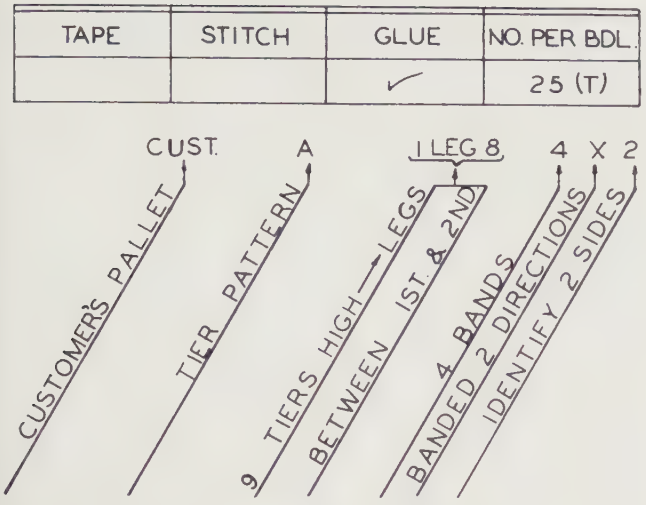


Fig. 1. Unitizing instructions

If a frame is to be used, it must be typed in directly after the instructions, as must any markings other than standard. It is standard practice to put protectors under all bands and stencil quantity on units.

Figure 1 is a graphic illustration of the instructions.

UNIT FLOW THROUGH PLANT

The progress of the unit through the plant will certainly vary depending on the plant's layout, equipment, and volume of unitizing. Approximately 5 to 10% of our material is hand-banded, excluding sheets banded at the corrugators. This is done either on portable conveyors, wheel trucks, or portable stands. The bander generally moves from unit to unit and even at best, it is slow. The trend seems to point to a centralized section for unitizing where semiautomatic compression and strapping equipment can be employed. In our plant, all finished material from three gluers, a jumbo taper, two general tapers, and five stitchers go on a common conveyor. All unitized work is fed to two Acme banders; all nonunitized work is piled on 48 by 60-in. factory pallets. Both are then either loaded or stored. In addition to this, all domestic sheet orders from the corrugators and printed work from the presses are precounted and placed on this conveyor for unitizing when called for. The straight unitized order presents no problems in handling. With two Acme banders we have strapped as many as 620 units in one shift, or 38 per hour per machine. I don't wish to infer that this is just routine. It was work, but nevertheless, accomplished.

SPECIALTY PALLET

Let us look for a few minutes at a unit employing a specialty pallet. It is a 72 by 120-in. Government pallet made of three pieces of 2 by 4 lumber the 72-in. way and held in position by two 120 in., 1 by 4's in the opposite direction. The 0 by 0.035 strapping has to be stapled to 2 by 4's top and bottom. V3C sheets are run directly from the corrugator on to the pallet to a height of 300 sheets, banded, and carried away for inspection. Loading these 3800-lb. units is now simple A fork truck is positioned inside a 50-ft. car. Nailed to the car floor are 1 by 4's 54 in. apart and then greased. The units are tiered two-high in the car. The inside fork truck then easily pushes them to the end of the car. Nine of the ten units can be loaded by fork lift. The last one must be put in by hand and banded after loading. The fork lifts can do their part in 40 to 45 min. per car. Fifteen cars have been loaded by four men on two shifts. This includes all time spent cleaning and preparing cars.

HANDLING CUSTOMERS' PALLETS AND FRAMES

The biggest single problem to high speed unitizing is the unit employing the customer's pallet with frames. It is similar to the pressman who wants to get out 100,000 blanks but has nothing but a reverse warp on the board; progress is slow. We first start with the pallet and the bottom frame. Next the pallet is placed on the conveyor with runners positioned so that they will run smoothly without juggling the load; then to the compression unit where the top frame is placed on. The strapping can not go under the pallet runners, so the operator must insert two guides in the pallet for the banding wire. This must be fed in by hand from the back of the machine. The bands must stay in line with the runners of the frame to prevent undo distortion of the boxes, and to keep the frames from breaking. The frames must also cover the entire unit and extend over it about $^1/_2$ in. The unit must then be turned and strapped in the opposite direction. Care must be exercised at this point because the pallet runners are apt to bump over the conveyor rollers and result in a distorted unit before banding the second way.

NEW EQUIPMENT

It is pertinent to mention at this point that the Signode Steel Strapping Co. has a new model steel strapping machine which incorporates a chute system for doing easily and automatically just what was done above with difficulty. Coupled with its built-in turntable and automatic indexing for positioning of banding wire, this machine should reduce the banding time for this type of unit from 3 to 4 min. to about 1 min. It can handle units from 32 to 84 in. in height. The cost for one of these may run as high as $17,000—depending upon the extras that are incorporated in it.

Another automatic bander is the "Royal-Pak" developed by Royal Pioneer Container of San Francisco, Calif., in conjunction with the H & C Container Machinery Corp. of Sunnyvale, Calif., and the Signode Steel Strapping Co. This machine "Handles cases in multiples of 175 "B" flute, 140 "C" flute, or 105 "A" flute at one time. It provides:

"1. Speed plus 20 to 50% time saving in unloading.
"2. Ease and efficiency in handling.
"3. Saving of 10 to 20% in warehouse space.
"4. No pallets to be handled, stored, or accounted for.
"5. Saving in inventory time.
"6. Runners used can be stored in a fraction of the space required by pallets and they may be easily stored by you for pickup or return to us.

"All this costs you not one penny more than the old fashioned method of hand-tying 25 cases to the bundle. Progress for your convenience and economy."

This machine can be ideally located at the end of a folder-gluer and is best suited to volume runs of can size type boxes, but it will handle any size run on the folder-gluer down to a 13 to 24 in. knocked down dimension. It will handle only one size at a time. The Royal-Pak will cost $30,000 to 35,000.

TRIPLE-WALL PALLETS

There has been a growing need for an inexpensive expendable pallet. This need comes from our customers for the shipment of his product. To replace what he is currently using, L. Davidson of the Pallets for Industry Co. of New York, N. Y., has developed and patented an expendable die-cut triple-wall pallet. This pallet is shipped to the customer in the flat die-cut form for him to set up for use as required. It can be engineered to suit his specific size requirements. It will support 1000 lb. in shipment and up to 2000 lb. of stationary material. Storage space is one-tenth that of

conventional pallets, and the cost is from $0.70 to $2.50 less depending upon the type of pallet previously used. At the present time, Connelly Containers, Inc., and Star Corrugated Box Co. are the only licensed manufacturers.

TURNTABLES

We have devised a turntable that may be of interest to you. The first ones we tried consisted of a plate 42 in. square with steel balls of various sizes spaced in various ways. None of these worked because of the units being too hard to turn causing frequent distortion sufficient to require repiling. The second one was an 11-in. plate turning on an antifriction thrust bearing which is mounted on a base plate. This assembly is mounted on two air cylinders. The third is an 18-in. model on three cylinders and centered in a 60-in. wide conveyor which extends for 10 ft. on either side of the compression unit. The balance of the conveyor system is made up of $2^1/_2$-in. diam. rollers, 42 in. wide spaced on 3-in. centers.

HANDLING FROM CONVEYORS

To remove the unitized load from the conveyors, we have adopted a nonanchored section of conveyor (5 ft. in length) to prevent damage when hit by forklifts. It has two permanently spaced openings to allow forks to enter and lift the unit off and two inserts for these openings which can be easily put in to allow troublesome units and pallets to pass over without upsetting.

WAREHOUSING

Once the unit has been completed, there remains only one of two things to do with it: (1) load it; (2) store it for future delivery. The latter seems to be coming upon us at an almost alarming rate. The problem is to find or create space to store it, keep it in clean condition and maintain an accurate inventory. The latter is most important because, if you don't, a new order may be processed and shipped without even touching the stored item. I don't know what other companies are carrying for stock or future delivery, but we have currently 134 items in stock for 51 customers. This keeps our 30,000-sq. ft. warehouse about 75% full most of the time. This area is separate from the shipping area for outgoing material. It is our opinion that the creation of warehousing space is good practice, promotes business, and provides services not possible before. It has also cleared the production area for production . . . which I feel is contributing to lower costs and more square footage shipped.

LOADING

The loading of unitized cars and trucks is not a problem in itself. We make every effort to fill in void spaces in car doorways with loose bundles to eliminate a shoring job. Trucks are not particularly difficult to load, but a very definite space problem is encountered resulting in less volume per load.

At first we had difficulty securing the units on conveyorized trucks. There was the too frequent call from a driver that a unit had broken loos in the middle of Main Street. We feel that we have overcome this with the use of a metal chock shaped like an elongated small "h." It fits over two rollers of the conveyor and is placed behind every other unit. At the tailgate, it is positioned by lifting the last unit with a forklift and placing one or two directly under it. When the unit is lowered, it anchors the chock in place. There have been no more "Main Streets" since these have been put into use.

The use of flat-bed trailers helps to solve many volume problems of unitized truck deliveries. In many cases the quantity delivered can be doubled, tripled, or even quadrupled. Unfortunately, the big limiting factor in this part of the country (East) is the weather, particularly if the customer does not have a protected unloading dock. Nevertheless, we favor flat beds and currently have five of them out of 34 trailers. With each old body that rusts out, we gain one more flat bed and more volume per delivery.

PALLET COST AND OWNERSHIP

We have looked at large units with special pallets, and units with customer's pallets and frames. The question may arise, "Where did the pallets come from?" We buy government pallets costing $8.00 to 15 each. Others, generally speaking, are supplied by the customer who bills us anywhere from $1.50 to 3.75 per pallet. When they are returned, the customer credits us one for each unit shipped. In every case the $0.90 frames are our problem from beginning to end; that is, we either make or buy them, or repair the used ones picked up at the customer's plant. There is also the customer who wants unitized loads on pallets but he has none of his own. You may have to use any one of a dozen customer pallets that you have in stock. You can obviously see the pitfalls created by such a practice. It is one that must be resisted with every effort.

We have recently started supplying pallets for use to some customers. The purpose was twofold: (1) to replace required legs and bottom frames with a $3.00 ten-trip pallet thereby affecting a net saving of $0.95 per unit; (2) to replace the hard-to-unitize-and-handle leg unit. We started with 50 of these plus top frames and found this to be entirely inadequate to service the account. We now have over 150 in use. At the beginning, we found an average of 20% damaged of those returned. We upgraded the lumber used, and the cost to $3.28. This has resulted in very few damaged pallets. Should we bill the customer for pallets and credit him upon the return of same? This is certainly a very delicate subject as far as the sales department is concerned, but an expensive one as far as the factory is concerned.

MAKING PALLETS

To help overcome some of the cost in the buying and repairing of pallets and frames, we hav recently entered, on a small scale, the pallet-making business. We buy lumber in carload lots and also salvage a surprisingly large amount from inbound freight cars. We make and repair pallets, skids, and frames. These are stored on a 12 by 350-ft. platform which is filled to 80% of capacity most of the time. I cannot say at this time just what economies, if any, have resulted from this program. One thing we are certain of is that we can get them in a hurry when needed. (It might be interesting for you to know that this platform is located on the opposite side of our railroad siding. In lieu of installing a bridge, we bought an old flat-bed freight car and move it around as a bridge to suit our needs.)

COST

The volume of unitized shipments has been steadily increasing. How much is it costing to do it? One small-scale survey indicated that those reporting felt that it was costing them $3.13 per unit. On the same reporting basis, our figure would be $1.41 per unit based on a 14-unit load. The largest item in this is the space loss cost of $0.99 per unit. This does not, however, take into account any of the offsetting advantages of unitizing. I do not have facts and figures to prove to you that unitizing is either an expense or a profitmaker. Whether or not there should be a charge for it is a question that can be answered only by the industry as a whole. My feeling is that there should be a charge where we supply pallets and frames, and when space loss exceeds a given percentage.

PERCENTAGE OF SHIPMENTS UNITIZED

We are currently unitizing 92% of all carload shipments and 46% of truck shipments. This represents about 75% of total volume. Our average unitized carload represents 85%

of volume, the average truck load 77%. In contrast to this the average bundled carload averaged 95% of volume and 93% for bundled truck loads. To offset some of the volume loss of truck shipments, unitized loads were unloaded in an average time of 1 hr. 58 min., while 5 hr. 15 min. were required for nonunitized full loads.

ADVANTAGES

To support the merits of unitizing, I can tell you that 4 years ago we had 22 men in the shipping department working six days a week. We now have 26 men working $5^1/_4$ days. This represents a 5 3% man-hour increase to cover a 28% shipment increase. We have five full-time shipping forklift trucks against one 4 years ago; six full-time banding men (five on automatic banders, one on hand banding). Four years ago we had at times as many as six men banding on one shift doing about the same as one man does now. We now have two $15,000 automatic banders against a dozen hand tools in the past; we buy 5 to 6 carloads of banding wire now as opposed to one carload in the past. But, unitizing, where used, has practically eliminated the need for twine. It provides an outlet for scrap sheets in the form of top and bottom protectors. Unitizing has reduced loading time. It has increased our storage capacity thereby keeping the production floor open for production. During a three-week period the factory averaged 20.5 million sq. ft. per 46-hr. week, and I feel sure that this would not have been possible without the benefits of unitizing.

CONCLUSION

In conclusion, I must say that I am unable to tell you what unitizing costs per unit or per 1000 sq. ft. shipped. It is something that has grown on us at an increasing rate. We like it; we encourage it; we do it consistently for our own convenience. Nevertheless, it will require intelligent efforts on our parts to help educate the customer and guide him along lines that will be of advantage to both of us. If we recognize that there will be a need for frames because the customer must have flat, undistorted boxes for his automatic equipment, legs in units because he does not have chisel forks, and pallets because he has only a hand-fork jack, then we will be headed in the right direction. The right direction may also mean training our production employees, our Georges, guiding our customers, buying new equipment, changing layouts, and increasing the number of forklift trucks and creating warehousing space. If we plan ahead, I feel sure that you will feel as I do that unitizing is here to grow and that it can help us increase production, lower costs, give better service to the customer and help us achieve the final satisfaction of attaining what we are all striving for—increased profits.

Received Mar. 21, 1960 Presented at the 45th Annual Meeting (Corrugated Containers I) of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb 22–25, 1960.

Operating Experiences with Tapered Mechanical Glue Roll Drives

ROBERT A. SHERMAN

Our investigations in the use of tapered mechanical glue roll drives were begun as a result of many requests from corrugated manufactureres to whom we render consulting services.

THE NATURE OF THE PROBLEM

Samples of board, combined at various speeds, were studied for adhesion qualities. It was quite apparent that there was

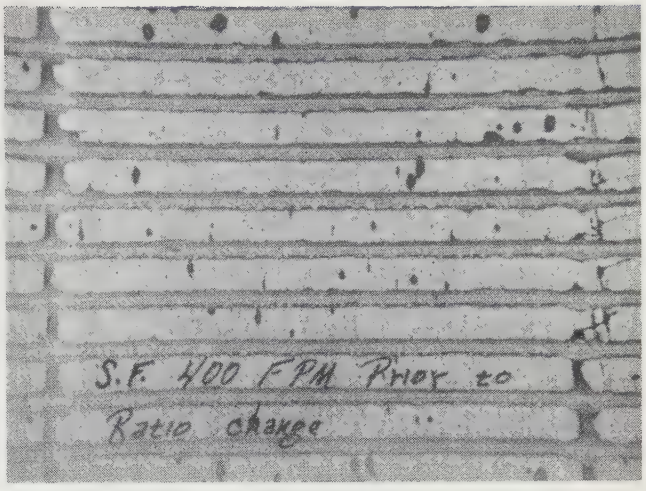


Fig. 1

a need for greater control of pin adhesion and top-to-bottom compression at all speeds. Throughout the speed range, our findings indicated an extreme variability of bonding which was either very good, limited, doubtful, or superficial. This pattern fluctuated under the same operating conditions from day to day.

We immediately checked starch formulation, mechanical condition of corrugator relative to bearing wear, the crown of adhesive, pressure, and corrugating rolls, heat transfer, finger adjustment, and all other check points. Iodine tests showed quite clearly that there was a lack of uniformity relative to the spread of adhesive on both single-face and double-face side. It was obvious that we were either flooding or starving the sheet, riding one shoulder of the flute or the other; and, in many cases it was quite apparent that there was considerable slinging between the flutes (Fig. 1). This happens on many machines without mechanical tapered drives especially at the higher speeds. It most definitely will happen at any speed where the surface of the applicator roll is traveling at greater speeds than paper. This is another reason why the adhesive roll surface should be traveling at a lower speed than paper at all times.

CONTROLLED GLUE-ROLL SPEED

After a comprehensive survey, our findings indicated that the most critical area of control was the spread of adhesive. Why is a controlled glue roll speed necessary? Prior to electrically, hydraulically, or mechanically controlled speeds, we had either the fixed ratio or no control. The fixed ratio was by far the best method, and even now is second best; it is still good if we do not like or cannot see the reason for varied control. Without fixed ratio, prior to varying control, machines had no control. Paper speed controlled the ratio between the glue-roll surface and the paper. At a slow speed, where the friction is greatest, the ratio would be 1:1. This is not good, because it is impossible to get proper distribution at this ratio; the minimal amount of adhesive is applied when the heat is greatest and vice-versa. Another fact to remember is that at 600 f.p.m. the available adhesive on the surface of the applicator roll is approximately 20% greater than at 100 f.p.m. For these reasons, controlled ratios are a necessity, and most technical men in the industry today are convinced that this is a must.

THE IMPORTANCE OF TAPERED BONDING

We set up, as our primary objective, control of pin adhesion and top-to-bottom compression at all speeds. In order to accomplish this aim, the proper taper is an absolute requisite, and since the bond on the single-face side of the sheet was more difficult to control than on the double-backer, we set up an all-gear, tapered, mechanical, glue-roll drive with variable control on a high-speed, A-flute single-facer.

Robert A. Sherman, Corrugating Technicians, Inc., Tenafly, N. J.

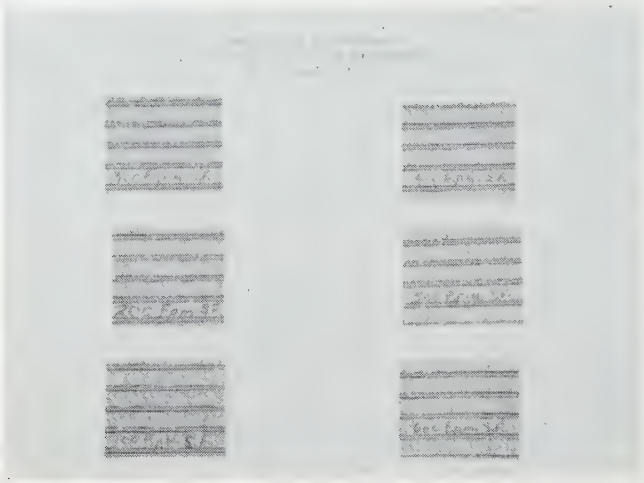


Fig. 2

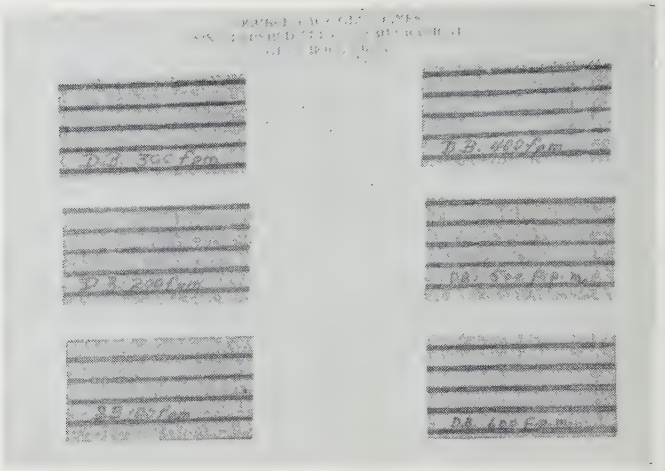


Fig. 3

Samples of board taken at 50-ft. intervals and at speeds ranging between 100 to 600 f.p.m. were manufactured at varying tapers. A specific optimal ratio was determined for each flute relative to the strongest bond and top-to-bottom compression throughout the speed range. It was found that the greater the ratio, the more uniform the pin adhesion throughout the speed range. With the proper ratio, the same pin adhesion can be obtained at 100 to 600 f.p.m. (Fig. 2). These pictures were taken of board produced on an all-mechanical glue-roll controlled machine. The preferred ratio on single-facers is: A-flute, 75 to 95; *C*-flute, 82 to 95; *B*-flute, 85 to 95. On double-backers it is 80 to 95 on all flutes. These figures do not mean that these settings are the only ones for all operations. These ratios are good for glue roll clearances of 8 to 9/1,000 on single-face and double-back, if the same number of flutes are in contact with the applicator roll on all stations, whether running single, double, or triple wall, with 150 lb. of steam pressure and on machines having a speed in the range of 100 to 500 f.p.m.

These are our recommendations. However, personal experience of the individual might indicate other ratios. The greatest ratio change is at speeds of 100 to 350 f.p.m., and is reduced gradually at top speeds. Since variability of orders necessitates the operation of many corrugators within this speed range, tapered drives are essential on older as well as modern machines. It might be well to metntion here that throughout this work we used a viscosity of 30 sec. on the corrugator and 60 sec. at the double-back. In a few cases, in order that we might get as high a pin adhesion test at 100 f.p.m. as 500, we were forced to use even a lower speed ratio, especially on A-flute. We do not advocate a pin test this high for day-to-day operation. This was only done for test purposes. This is why we say for your day-to-day operation you might like a higher ratio; which on low-speed machines might prove more satisfactory as well as economical.

We then proceeded to vary the facings in fluting material in paper grades other than the 200-lb. test; bonding, top-to-bottom compression, and pin adhesion responded in a similar manner to the 200-lb test papers. We also obtained much better quality control at the higher speeds with 69- and 90-lb facings; double-wall grades were combined at much greater speeds than previously. Regardless of the type of corrugating material or facings used, iodine tests showed controlled distribution of adhesive at all speeds, and this pattern remained constant. The setting of the glue rolls to the corrugating rolls also was reduced one thrid. This most useful factor reduced the "fluffing" of the paper and helped offset any variables in caliper and moisture of corrugating medium, which undesirables are especially noticeable at the higher speeds.

Our studies revealed that the poorest bonding occured at the slower speeds on machines without tapered glue roll drives. A tapered drive increased the effective utilization of adhesive consumed at the slower speeds, because an increased amount of adhesive was made available for better bonding at the higher paper temperature. Another contributing factor to the poorer bonding at the slower speeds was the full wrap of the liner on the 36-in, preheater at the single-facer where wrap is never decreased during spilcing, or whenever the corrugator schedule required continuous operation at the slower speeds.

THE TAPER PRINCIPLE AS APPLIED TO DOUBLE-BAKER

The pictures shown in Fig. 3 were also taken of board produced on an all-mechanical, glue-roll controlled machine. During our investigations we found the conditions at the double-backer quite different. One of the most vital settings is the positioning and alignment of the holddown roll over the single-face web. The taper principle, of course, reflects a greater wiping action at the slower speeds, and the most effective bonding and most economical consumption of adhesive are dependent upon accurate alignment and positioning of the holddown roll for the respective flutes and caliper of liner. Many of the glue stations are so built that if you have two to three flutes in contact with the adhesive roll on the lower station you may have 12 to 13 flutes in contact with the top station. This makes it impossible to get the same adhesive application on both stations with the same clearances, especially with a tapered drive. In a few plants where they run triwall board this conditin is further magnified. The loads and surges at the double-backer require a very sturdy tapered drive to control the glue rolls for spread of adhesive at all speeds, since the stresses are more severe than at the single-facer. This fact makes it imperative that a tapered drive be installed with a minimum amount of chain. If it is possible an all gear connection is by far the best. Some drives, especially mechanical, have as many as six chains. Whenever wear causes too much slack in these chains you will have a very irregular adhesive pattern.

OTHER CONTRIBUTING FACETS TO GOOD BONDING

Of course, all those factors which combine to make a good adhesive system are indispensable. I would like to enumerate some of these. Each batch of adhesive should be properly prepared using a high grade adhesive having a solids content of at least 20%, and stored at a constant, controlled temperature. The controlled temperature is a must because it is impossible to maintain a uniform viscosity without this control. It is also impossible to make a good sheet of corrugated board when the viscosity is varying from 30 to 60 sec. from hour to hour. The adhesive pans should have adequate circulation. Another important factor is the mechan-

ical condition of the pastes tations, parallel symmetrical rolls, adjustments for controlling roll clearances, adequate cleaning of metering rolls. These are some of the facets which must be kept in mind.

CONCLUSIONS

In the final analysis, any progressive mechanical device, in order to be accepted, must justify its purpose for existence. Will it produce better board more economically? The tapered glue-roll drive produces more board with less washboarding; less wrap, less scrap, and a uniformity of bonding at all speeds. Further, the adhesive cost of producing such a superior board is from 12 to 15¢ per 1000 sq. ft. This figure is no dream. There are several operators in this group today who are running at this figure, and at the same time using the most expensive adhesive materials obtainable. Five or six years ago in this very room we informed you these figures were possible. A few years back we thought if you were operating at a cost of 30¢ per 1000 sq. ft. using 3 to 4 lb. of dry starch per thousand, you were doing a good job. Today, if you are running at a cost of 20¢ per 1000 sq. ft. using 2 to $2^1/_2$ lb. of dry starch per thousand, you are still using too much. This cost of 12 to 15¢ is considerably less than adhesive costs for board produced on machines without tapered glue roll drives. And, the savings which are realized, in many cases, are truly staggering.

Received March 21, 1960. Presented at the 45th Annual Meeting (Corrugated Containers I) of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Scheduling a Container Plant

ROY P. CAPONI

I know it is getting late in the afternoon. Like myself, I am sure many of you have a very vivid picture right now of a frosted glass containing a tasty Manhattan or Martini and wish you were looking at and listening to the bartender instead of me.

If each of you can answer the following questions with an emphatic "Yes" you undoubtedly would not want to listen to me anyway:

1. Can you tell your sales department in 60 sec. where any given order is in your production cycle?
2. Do you schedule the sequence of every order through every printing press, finishing machine, and specialty machine as well as your corrugator?
3. Do your foremen have complete faith in the planning department's schedule so they might concern themselves with other important duties?
4. Do you tell your sales department every morning any order that will be late that day and why?
5. Do you know how many tons of backlog you have yet to cut up every minute of every day?
6. Do you have any assurance that down rolls will be run on your corrugator before a full roll of the same width and grade is shafted thus keeping down rolls to a minimum?
7. Do you perpetually inventory roll stock and plan to relayout roll stock areas periodically to insure lowest possible trim and upgrading?
8. Do you have a system for controlling obsolete stock, second grade materials, customer hold, and customer pickup items to insure holding each of these to a minimum?
9. Does your planning department schedule preventive maintenance on your machines as a daily routine?
10. Do you know when you have too much business for your die cutter, your waxer, your three color press, or any given machine or department?
11. Do you have a system that will insure that dies, ink, tape, special adhesives, and other material will be available before an order is scheduled? Can we answer yes to all of these questions? Yes, we can—although we shall admit to an infrequent exception.

Have we always been able to answer yes to all of these questions? Emphatically. NO! Back in 1948 when our company and the Chicago plant made its entry into the corrugated business we had a planning department that scheduled the corrugator but did very little in addition to this. Our individual department foremen scheduled their own converting operations with kibitzing from their operators, power truck operators, and even offbearers and did we have fun! Many times it was "Let's do the order by the aisle because its easy to get out; let's leave the hand-hole order for the other shift; let's not run the carload order, our offbearer is tired: let's not run the close register job tonight. I've got a headache." There was no way of knowing when an order would be available for shipment. Down rolls weren't run, orders were set up on the press to find ink was not in the shop, loads were missed, storage areas filled with obsolete stock, machines were not maintained. Customers must have been unreasonably reasonable. Then came the revolution as our sales department cooperated in spoiling our customers. This made us sit back and take a look at ourselves. Our turnover was high, quality only fair, waste high, morale questionable, safety record lousy, efficiencies low, costs high, training negligible, and our customer service stank. Who was responsible for quality, waste, turnover, morale, safety, efficiencies, costs, training, and a thousand other things. These were responsibilities of the foremen, who did not have time to worry with these things because he spent too much time scheduling the sequence of orders through his department, finding loads, making sure he had ink and dies (if in printing), wondering where he was going to get people to run extra machines, and figuring out ways of leaving the tough jobs for somebody else to run. The time left to worry with the other aspects of his job was little.

Relieving the foremen of this planning responsibility to give him the time to perform his more important duties began the planning evolution in our box plants. This evolution from foremen scheduling to our present day system was not easy, nor fast. Planning personnel had to be thoroughly trained as it is important that a man given the complete responsibility for scheduling converting operations be familiar with all machine limitations, normal sequence to secure lowest cost when service demands permit, must be familiar with standard set up and run speeds for all machines to determine approximate times each order will take to run, must be familiar with crewing on all machines and manning tables for all departments.

After training planning personnel in the above we held many meetings to explain our intent and purpose in the new planning system to all of our foremen and to our staff. We made it known from the very first day that our planning department had complete authority for scheduling all machines. If a red and black printing job was followed by white and yellow and back to red and black the foreman ran it that way. Our superintendent in many cases explained the need for this type sequence from a customer service point of view to help clear the path.

Whenever the planning department scheduled more machines in a department than there were employees, less machines would be scheduled in another department with advance notice given that certain employees with specific skills should move to the other department. In a short time our foremen were convinced that the planning department knew what they were doing, and were in the spot to know the most necessary sequence of jobs from a customer service point of view. Our foremen breathed a sigh of relief over the transfer of planning responsibility, they developed an unquestioning faith in the schedule and began to concentrate heavily on their other responsibilities.

Now a little about the actual scheduling process. Our sales department receives an order from the customer and prepares a typewritten order and assigns a file number. The sales department orders the necessary printing dies if this is a new item. If an old item they check their printing die records to make sure dies are on hand. A copy of this order is sent to

Roy P. Caponi, Plant Manager, Union Bag-Camp Paper Corp., Chicago' Ill.

the planning department. The planning supervisor looks at the delivery date and records the total tonnage involved on the order on his "to corrugate" backlog for the delivery week involved. If this is a repeat order, our planning supervisor gives it to our file clerk who pulls the ditto master of the production layout. This ditto master has a drawing of the carton showing all printing and dimensions, whether taped, glued, stitched, ink codes, lists of operations, shipping dates, and additional information. If a new order, the order is given to the layout planner who makes up a new ditto master with pertinent information. The file clerk lists the order on a posting sheet by delivery date listing the order, customer name, quantity, style, size, and operation sequence.

The file clerk then runs off copies of the layout on a ditto machine. One copy goes immediately to our die room where the die is made ready; one copy goes immediately to our storekeeper who makes sure we have enough ink, tape or special items the order may call for, such as ludox, tear tape, etc.; one copy goes immediately to our engineering department if it is to be unitized and a detailed unitizing diagram is made at once. An order is never scheduled through a finishing operation unless unitizing diagrams are attached to the production layout; our superintendent gets one copy of any new layout to see if anything special is to be encountered; our quality control department gets a copy of any new layout for a new customer and they follow it through the operation cycle; two copies are given to our accounting department, one for standard cost as we figure the profitability of every order we run, and one for inventory control purposes. A master quantity record is also run off and accompanies the order through the plant with each department recording the good production it has run. These production layouts are run on different color paper. All market sheet items are on pink paper as they are also used for load identification. If box blank sizes are very close together for the same customer we may use yellow for one size and blue for the other for ease in load identification in the plant. The file clerk will also run small 5 × 8-in. cards from the upper left hand corner of the layout master for our converting operations scheduler. A green card for taped or glued boxes and orange for stitched boxes, pink for one color, blue for two color, yellow for three color. A separate card will be run for both printing and finishing operations.

Finally the file clerk will run a layout for each load that we shall have with a few spares. These are sorted by flute, grade, and delivery date by our file clerk for the corrugator scheduler.

Our corrugator scheduler is worried first about making delivery dates: secondly about maintaining a comfortable backlog for our printing, finishing, specialty, and shipping operations so he is in constant touch with the two men who schedule these other operations. He might be told that unless he corrugates something for our VL press by 3:00 p.m. it will go down, or don't corrugate anything more for the die cutter. It is already overloaded and lets keep the material off the floor. He will then attempt to corrugate with the least trim and with as long a run as possible of the same flute beginning with the widest and heaviest combinations to the narrowest and lightest.

He works with a perpetual inventory listing of full rolls and down rolls which is kept up-to-date every minute. He schedules the down rolls to be used hence they never accumulate. Roll stock is ordered weekly using this listing. We aim for a minimum $^3/_4$-in. trim and order special sizes for repeat business whenever possible to help keep the trim to a minimum. We order our corrugating medium $^1/_8$-in. narrower than our liner as general practice.

At 6-month intervals we review our board consumption by grade and width and, if necessary, eliminate certain widths and add others, restripe our warehouse for these minimum moves, and maintain only sizes that move. In this way trim, upgrading, and strip waste is kept to a minimum.

As noted earlier the file clerk runs small 5 × 8-in. cards for the converting operation planner at the time layouts are run off. This planner must be thoroughly familiar with machine limitations, customer service requirements, standard speeds of all machines, and he must be cost-, efficiency-, and volume-minded.

These small cards first tell a story by their color as indicated earlier. For printing, the white card is for plain jobs, pink for one color, blue for two color, and yellow for three color. The card contains information as to delivery date, customer name, mode of delivery, type of manufacturers joint, ink color codes, and machine sequence. The card will show what presses this particular order might run on, due to size, colors, number out, die cuts, quality, etc. The box planner will estimate the hours required to process this order thru printing and will mount the card on our planning board on the line for the particular press that will run this order. In this way we always know every order in the house for every press. This includes all orders the planning department has in its possession.

When the order is corrugated the card for this order will move to the "ready to print" portion of the line for this press and be put into its proper sequence for service, color, etc. At 2:00 p.m. daily, a written press schedule is prepared to cover the sequence of running by press for the next $2^1/_2$ shifts. Order number, customer name, and delivery date are shown and spread across the sheet for as many hours as the box planner estimates the order will take to process. This schedule sheet is headed at the top in 1-hr. segments with machine numbers on the left side.

The printing department will not vary from this schedule unless the planning department okays the switch on the schedule. We have five presses and normally run only four per shift. The planning department schedules a different machine down daily for preventive maintenance and cleanup. In this way printing quality and speed is more easily maintained for the long haul.

The planning department issues a report each afternoon to the maintenance supervisor informing him of all machines in the plant that are scheduled down the next day so he, the maintenance supervisor, may schedule his crew accordingly.

The finishing operation is scheduled in the same manner as the printing department. Cards are mounted on the board behind machine listings on which they will run. When the order is scheduled in printing it will also be scheduled in finishing with sufficient ink drying time allowed. Since these cards are always mounted behind each machine number it is easy to see what machines are overloaded or not sufficiently backlogged. This information is communicated hourly to the corrguator scheduler.

I mentioned, near the beginning of this paper, that the file clerk listed each order on a posting log by delivery date. Thus every order the planning department has in its possession is listed on this posting sheet by delivery date. All corrugated running is posted to this sheet showing date corrugated and quantity; all printing, finishing, and specialty operations are posted to this control sheet also. Anytime anyone wants to know the status of an order he asks about customer order so-and-so for such a day's delivery. The order listing is easily found—if corrugated and not yet printed, the planning supervisor asks the press scheduler where the order is and will be told when it will come off the press. Within 60 seconds the sales department can find out the exact status of any order.

How else does our sales department get information on the delivery status of current orders? Each day at approximately 2:00 p.m. our planning department prepares a shipping schedule. This schedule is prepared from the posting log showing everything that must deliver on the following day. This shipping schedule will also show all orders for previous day's shipment which have not yet left the plant. This schedule will further indicate the current location of each order indicating, for example, that an order is already com-

pleted and in the shipping department or that it is in the finishing department or specialty or printing. The shipping foreman can use this schedule to prepare his truck itinerary for the next day. He may also use this for scheduling the number of cars he needs in the correct car sizes. If a particular order is shown as in the finishing department, the shipping foreman will refer his copy of the finishing department schedule to ascertain whether or not this order will be completed in time to ship the next day.

At 9:00 a.m. the following morning, this shipping schedule becomes the focal point of a meeting in the shipping office. In attendance at this meeting are the shift superintendent, the shipping foreman, the planning representative that schedules the converting operations and a representative of the sales service department. Every order on the shipping schedule that should ship on this date plus any that should have been shipped prior to this date are reviewed. In half an hour it is determined which, if any, of these orders will not ship this date and why. If the sales service representative is aware that one or two orders which will obviously not ship according to the current schedule would cause grave customer concern, the schedule may be changed right then and there to accommodate these orders. It will immediately be obvious which other orders would be affected by the switch. Also apparent at this meeting will be the status of matched set orders which are grouped on the shipping schedule. For example, if four items out of five are in the shipping department ready to ship and the fifth item is in the specialty department awaiting a chopping operation, the specialty schedule will be checked. If this item is not on the specialty schedule it will be inserted if this change would not affect a more important service problem. In this way matched set orders receive special attention. They have also been watched daily by the planning supervisor as he checks his log sheet which also groups matched set orders.

If a schedule change has been agreed upon at this meeting, the shift superintendent will relay this information immediately to the foreman of the operating department involved in the switch and an interchange of personnel between departments will also take place if deemed necessary. The sales representative takes back a copy of this shipping schedule that has been marked with certain deliveries that will not be made as promised. These customers will be telephoned and notified that their order will not ship that date. Normally customers so advised are pleased to be remembered and concede another day or two for delivery. If an occasional customer, who is called, is adamant about delivery we shall again review the schedule and attempt to make the delivery in question.

As pointed out earlier, we have five presses with only four scheduled and have this type of flexibility throughout most of our operation. Whenever additional "must" shipments rears its ugly head we can schedule another machine. In the Chicago area we have, on occasion, utilized casual laborers who can be used for from 4 to 8 hr. and are available on one hour's notice. These laborers are used to supplement our own personnel in offbearing jobs, loading jobs, stripping, and other unskilled operations to add to the flexibility of our operation. Overtime is also employed as a flexible tool when the shipping shedule indicates an abnormal number of orders running late.

At the beginning of my paper you may recall that the planning supervisor kept an up-to-date tally of tons to be cut up on the corrugator by week. Knowing what our average daily cutup is, we review this backlog figure no less than three times a day to ascertain the need for corrugator overtime. This same backlog figure if negligible might also indicate the need for scheduling short shifts throughout the plant which has been done in the past. In addition to making out the daily shipping schedule, the planning department also makes out a daily listing of items on the floor for customer pickup indicating the date thereon that the customer originally asked for this merchandise to be available. The sales department uses this listing and calls customers daily to remind them that their material is ready for pickup. Anytime any customer gets woefully behind in picking up old items this subject would be discussed between myself and the sales manager. Also prepared by the planning department is a listing of customer hold items: items that are complete but held for customer release. The date that the item was originally put on our floor is included in this report and acts as a control against the accumulation of too much tonnage in this category without anyone being aware of this situation.

Whenever any foreman in an operating department runs material which is subquality, not useable as a first grade box, for the original customer, but having utilization as a second grade container, these boxes will be finished and two samples brought to the planning department with a notation as to the quantity involved. The planning department will list the item and the quantity, list the department responsible for the poor quality and turn the samples over to the sales department for second grade sale. The container will be moved directly into a second grade material area. The planning department will follow on each item of this kind and if not sold within a reasonable period (the period being 30 to 60 days depending upon the quantity involved) the item will be baled. Whenever an overrun is made the shipping department will report this condition to the planning department and an immediate decision will be made as to whether this item should be held for a future release, whether the item should be included as available for second grade material sale or whether the item should be baled. The system is effective when everyone cooperates and is instrumental in maintaining good housekeeping and maintaining good work-in-process flow. As an added feature in waste control, sheets run at the corrugator that are blistered, out of line, short in length, having a misplaced score, will be salvaged and sent to a stock area in our specialty department. Before corrugating any stock for pads, scored sheets, partitions or small pieces of interpack, the corrugator scheduler will lay these layouts aside and our specialty foreman will check these layouts each day to ascertain whether or not these items can be taken out of stock before the item is corrugated.

I could go on and on concerning controls derived from some of the planning procedures I have described. Many meetings are held with operating foremen to discuss items such as overruns, shortages, second grade material, butt roll utilization, waste, and other factors based on reports covered above. How much does all this cost and how much is it helpful to us. Our planning department consists in total of five people. Our planning supervisor who coordinates the entire operation, orders the roll stock and maintains the contact with the sales department. Our assistant planning supervisor, who also does all the layout work on new items, orders cutting dies, ink, and coordinates the handling of printing dies. This man also schedules the specialty department. The third man is the corrugator schedule clerk whose duties have been covered above, the fourth man schedules the printing and finishing operation and helps coordinate the shipping schedule with the planning supervisor, the fifth member is the file clerk whose duties have also been described generally.

The total cost salary wise is approximately $30,000 per year. As a result of our planning department's activities and evalution to the point where they are the heart of our operation we have reduced our trim, eliminated upgrading, eliminated the undue accumulation of obsolete stock, decreased turnover, improved our safety record, increased training, improved our preventive maintenance program, reduced customer complaints, improved customer relations and number of deliveries made on time, improved union relations with only three grievances within the last 4 years, etc.

Certainly not all the gains we made in all the above areas are attributed to the planning department alone but planning is certainly a factor either directly or indirectly as we have

released the foremen of certain responsibility in planning to devote his time to these other activities.

In September, 1959, we had a spectacular $300,000 fire at our Chicago plant. Approximately 1750 out of 2300 tons of our roll stock inventory were rendered useless by either fire or water damage. Through following our established systems our planning department was able to coordinate the purchase of needed stock and so scheduled all of our operations so that not one hour of converting time was lost in our plant—and no customer was told that we could not make a specific delivery.

In closing, I recommend only that each of you look carefully at your own planning organization. If you feel that you are not realizing all the advantages that you could—plan to move slowly, methodically, but relentlessly with communication being present in every move you make. Capital invested in planning will pay dividends.

Received March 21, 1960. Presented at the 45th Annual Meeting (Corrugated Containers I) of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Product Development and the Production Merry-Go-Round

H. J. SCHLOTTER

The manufacturing of corrugated boxes is, as this group has chosen for its basic theme, somewhat of a merry-go-round. In our case, for example, we even approach the process on a somewhat circular basis with raw materials arriving at point X, proceeding through the various stages of processing in a more or less circular path to again arrive at point X for movement out of the plant for delivery to the customer. This, then, is our production merry-go-round with this endless flow of product, with animation supplied by men and machines.

If we agree in general and proceed with this concept, then how does product development fit into or upon this merry-go-round? Does the merry-go-round break down or does the new rider climb aboard with minor trembling of the giant wheel?

Product development, then, is an outside force which acts at intervals upon the smooth and happy ride of routine processing. The exact effect on the corrugated process is never the same but, with proper communications and leg work, most of the major bumps can be smoothed so that the new development will fit within the framework of routine production.

With us, the concept of new products is twofold; the first being the creation of new designs based on past practices and the fertile imagination of our designers using the materials at hand. The second concept is the development of new treatments, machines, methods, and/or additives to present materials to make them suitable for specific uses as the corrugated market expands. Other ways of looking at this same concept is (1) the improvement of existing corrugated designs, (2) the development of entirely new design styles or techniques in the use of corrugated, and (3) the development of markets through new raw materials, innovations, machine improvements, or methods of packaging.

Both of these, the day-in day-out changes and what might be termed major developments, are of vital importance to our planned expansion in the corrugated industry. We know, for example, that the creation of new designs has accounted for some 50% of our total business and that in new business it is the major factor in clinching sales. This design phase of our development program is fairly well established; however, being an infant in a sales-conscious industry, its status and total worth are often neglected. This, I feel, has caused many companies to be followers rather than leaders and has resulted in a high rate of personnel change which for the most part should be stable with good continuity of thinking. For this reason, I think that the screening and selection of design personnel should be as exacting as that required by top level personnel.

The second phase of our product development, and the one which I am more directly concerned with, is new materials and manufacturing techniques or methods as they pertain to the production and use of these new materials by our customers. This is the phase where most production men start to rebel, since it is here that the merry-go-round of routine is often broken.

A recent example of product development on the production scene, and one with which I am sure you are all familiar is the wax-impregnated boxes which have come on the market for fresh pack poultry, fish, vegetables, and fruits. Their appearance on the production scene was eyed with a considerable amount of reluctance which to some degree was not without justification. Our initial work at the actual production level was overly simplified, crude, and messy. Any of you who are now processing clean fast running corrugated can appreciate what an impact this new development would have on your manufacturing system. Even so, we were able to set up and produce production runs for field tests within a relatively short time, much of this being attributed to the cooperative attitude of the plant superintendent and by getting different ones to take part in the final stages of installation by contributing their ideas. These minor and sometimes major suggestions on how to get a certain end result is often the key between success and failure. For the minute one of these people has become part of the development work, he is going to do everything possible to see that it is a success. Our major function after this stage is to see that the final product has the desired properties to meet the shipping requirements of the packer.

I am sorry to say that at this writing we have stopped any concentrated effort toward a smooth running automatic machine for this product. This has been done, even though we have one of these machines on the drawing board, because of critical requirements of the major field we had hoped to capture and the present competitive price situation. Even so, I feel that the basic hurdle of production acceptance has been passed and if we should proceed with the building and operation of such a machine, it would not disturb the production cycle appreciably.

Another example of production change which envolved a new material, a new machine, and a new method of operating certain parts of our basic machine, namely the corrugator, is the spraying of silicone. This development of silicone spraying which is the application of a release coating to corrugated board so that various rubber compounds—camelback, butyl rubber, asphalt, etc.—do not stick or pull fiber even after months of contact.

In applying silicone to corrugated board, we were advised by our customer that the material must be applied only to the body panels. On the corrugator this meant that a method would have to be devised to get a well-defined band of from 18 to 24 in. wide and on two or more out, additional bands would have to be provided for. To accomplish this, a number of methods to screen the various segments were tried with varying degrees of success; most of these methods being rejected because of dripping as the atomized material collected and began to flow. To overcome this, and what finally became our present method of obtaining bands of coating, was to develop special spray heads which would in themselves apply the coating in bands. This solved our problem by eliminating all shields or other equipment over the paper web on which droplets could collect.

Another problem which we immediately encountered on

H. J. Schlotter, Director of Product Development, Hoerner Boxes, Inc., 600 Morgan St., Keokuk, Iowa.

our first production run was extreme warpage. To counteract this warpage, the wrap at the double backer was changed as would be done under extreme conditions but this was more moisture than had ever been encountered in the past. It was in this situation, when what appeared to be a noncorrectable warp, that the operating foreman was told and shown what was needed and asked if he could do it. The result being that, with a re-threading of the double backer, and increase in speed, and the application of moisture to the double face side of the sheet, the blanks flattened out and what was once a serious problem ceased to exist. This getting the production people into the act, as I have pointed out before, is many times extremely helpful in solving existing problems and by so doing getting a much greater degree of acceptance of the new development.

Our customers have also requested that a dye be added to this relatively clear material so that uniformity of application was readily visible. The color chosen was red and as you know, in a spraying operation, it soon tends to coat all surrounding equipment. This discoloration of equipment while not injurious does soon become unsightly and we feel will require an exhaust system both for appearance as well as personnel morale.

In the last 6 months, we have treated some 200,000 boxes with excellent end use results. In fact, the performance of these boxes was much better than previous treatments and by laboratory tests were superior in release properties to that of any similarly treated material presently on the market. The end result being that we now have customers who are pleased with the performance and we are anticipating a number of new accounts where sticky products are a problem. Some of the resistance which is built up between product development activities and the production process can be attributed to failures which do occur. These failures make production people reluctant in their cooperation since the attitude of prejudgment is readily acquired after one or more failures. To overcome this, there are probably as many answers as there are projects, the ideal being the pilot operation which is completely isolated from production. In such an operation, the flaws and setbacks can be ironed out without interference with production men or machines. This also results in workable production installations where the incidence of failure is negligible.

Another method of overcoming this problem of interweaving product development activities with production is to pick the plant which will benefit greatest by the success of the program. This method depends of course on the assumption that you have more than one plant from which a project can be launched. This distribution of projects also helps to minimize the feeling that a certain plant has been overworked with unproductive activities. One major drawback to this type of program is that development personnel is spread too thinly to get quick and accurate answers on which management can base their decisions. As a result, product development may get on an unwanted merry-go-round of excessive travel "guesstimates" instead of facts, and a high percentage of projects without provisions for terminating them. Or, if terminated, they are usually at stages of inconclusion so that the chances of a new product being a reality is doubtful.

The last method of development work in production is the one where everyone gets into the act. In this case, anyone who has an idea jumps in and carries on their own, usually secret, work, because of the high incident of failure. To put this another way, this type of development if successful will be the talk of the company but, on the other hand, the failures are never recorded and the ideas if of any value have been lost because of improper handling. Once one of these good ideas has failed because of improper handling or planning, it will be exceedingly difficult to get appropriations to handle further development work along these same lines properly. The stock answer is, "we've tried that and it won't work." They have failed to answer the one vital question, "why" and they have no facts or records of what actually took place.

My point in bringing out these three possible methods of product development as it affects production is to show how the merry-go-round can operate smoothly, as in the predetermined pilot operation, or bumpy but not impossible as in the semicontrol program, and the last exceedingly rough method with little chance of arriving at any destination other than failure.

The success of the introduction of any new development to production depends on the basic approach of selling all parties on the need, advantages, and the resulting benefits. True, we must have technical competence, we must know the total production process, we must be able to communicate ideas and principles and last, but not least, we must recognize the human factor, treating it with the Christian values which all individuals deserve.

Received Mar. 21, 1960. Presented at the 45th Annual Meeting (Corrugated Containers II) of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

New Methods for Production Control of Colloidal Silica Antislip Applications on Corrugators

BURT MENDLIN and H. J. WILHOYTE, JR.

Current literature contains many references to the need for reducing the slipperiness of corrugated containers. This need has resulted from the use of highly mechanized handling methods at all stages of manufacture, handling, and use, and from the trend toward smoother board finishes and glossier inks.

Prominent among the available methods of reducing slipperiness is the use of colloidal silica applied at the corrugator.

Cornell Paperboard has been using this method for over two years, having first tried pebbling of the outside liner and then application of various antislip materials and inks at the printer. The method has been relatively inexpensive in materials and setup time, but nevertheless has been a headache to the operators because of erratic test results obtained at times. On one occasion, friction coefficient measurements made on blanks from each of 22 loads of a carload order varied from excellent to poor. The variations were blamed on:

1. Corrugator operators who were not constantly alert.
2. Equipment which malfunctioned.
3. Testers who didn't know how to perform the tests.
4. Test equipment which was unreliable.
5. Paperboard whose surface characteristics varied very widely.

After many series of tests, it could only be concluded that a good job could be done most of the time, but we really didn't know what we were doing on the corrugator.

Cornell convinced du Pont, manufacturers of "Ludox" colloidal silica, that there was real need for study. Ortman-McCain, whose spray equipment Cornell was using, asked to take part in the study and a project was set up. The objectives of the joint program of study were narrowed down to: (a) accurately measure the magnitude and uniformity of silica deposits applied when spraying over a range of operating conditions, (b) correlate these measurements with increases in coefficient of friction, and (c) develop the means to control the variations that were thought to exist.

While much remains to be done, it is believed that the experience and findings thus far constitute an important step forward for the industry.

Burt Mendlin, Cornell Paperboard Products, Milwaukee, Wis.; H. J. Wilhoyte, Jr., E. I. du Pont de Nemours & Co., Wilmington, Del.

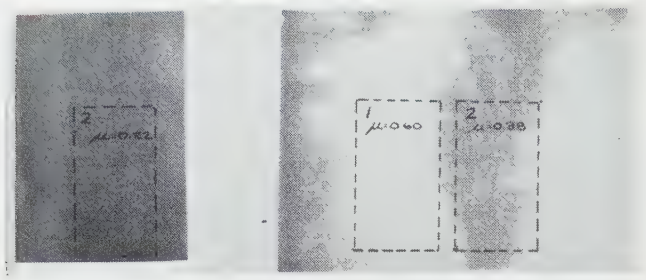


Fig. 1. Colloidal silica deposits on corrugated board traced with a fluorescent dyestuff

μ = static coefficient of friction.

MEASUREMENT OF COLLOIDAL SILICA DEPOSITS

Early laboratory work by du Pont and others indicated that the optimum level of silica deposition was approximately 0.1 lb. of silica solids per 1000 sq. ft. of board surface. This naturally led to the concept that production control consisted mainly of determining the silica add-on or spread for a given production run. Among the methods tried or suggested were: (a) calculating spread from records of board produced and silica consumed, and (b) analytically determining spread by x-ray spectographic methods, or by a molybdenum yellow colorimetric method, both described by McEwan, Beimler, Kaelble, and Taulli (*1*); or by variations of these.

While potentially useful, these methods did not yield the spread values until the board was finished and sometimes not until after it was shipped. The analytical methods are costly and in all cases results are difficult to interpret. Also, unless many individual samples are taken, such methods reveal nothing of the uniformity across the web or in the machine direction.

Most boxmakers use only the spread figure and their subsequent antislip evaluation tests may not be related consistently to the calculated spread.

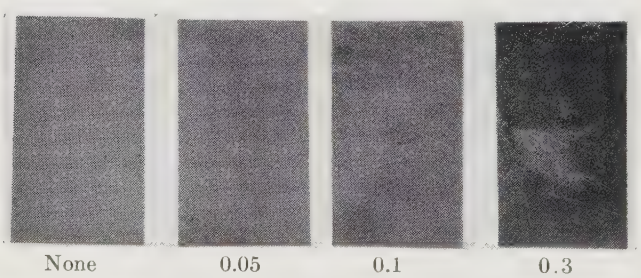
The ideal control method was conceived to be a rapid, inexpensive, direct reading device for the amount and distribution of silica deposited that could be used by the machine foreman during setup and production runs. This was the solution sought in the first phase of the joint study.

A Fluoresent Dyestuff Technique

The first approach made use of the fluorescent dyestuff, du Pont Paper White BP Solution, to trace the presence of colloidal silica when examined under ultraviolet light.

About 1 lb. of Paper White BP Solution was added to 20 gal. of a colloidal silica spray solution containing 15% silica and the solution was sprayed in a normal production run.

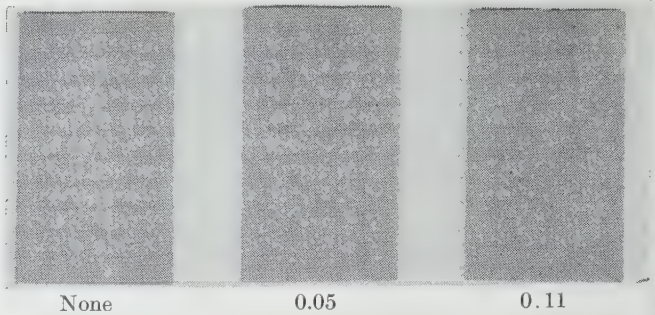
When the board was examined under ultraviolet light, the deposition of the silica solution was shown clearly. Figure 1 shows a representative result using this technique. The fluorescence is proportional to the amount of silica present per unit area. Confirmation of this is indicated by the coefficient measurements shown on the board samples.



Pounds of SiO_2 per 1000 sq. ft. of paperboard surface

Fig. 2. Variation in indicator color intensity at three levels of silica deposition

42-lb. fourdrinier kraft linerboard.



Pounds of SiO_2 per 1000 sq. ft. of paperboard surface

Fig. 3. Variation in indicated droplet frequency at two levels of silica deposition

42-lb. fourdrinier kraft linerboard.

The fluorescent dye technique showed us the reasons for lack of uniformity in performance testing which will be discussed later. The technique requires careful addition of the dyestuff, an ultraviolet light, and a darkroom for testing, but it is effective and would have been our production control tool except that a better one was found.

Indicator Method

Concurrent with the trials and testing of the fluorescent dyestuff, a search was made for a material capable of showing directly the presence of dried deposits of colloidal silica. Such a material, in the form of an indicator solution, has been found. It appears to completely fulfill the objective of measuring the magnitude and uniformity of silica deposits rapidly, inexpensively, and easily.

The test area of the board is painted with the indicator solution. If colloidal silica is present, a distinct blue color will appear, the intensity of which is proportional to the amount present.

Figure 2 is a color comparator which shows the relationship between color intensity and colloidal silica deposition per 1000 sq. ft. on a typical kraft linerboard. Color comparators such as this will enable users to estimate the amount of silica present on linerboard.

Color comparators such as shown in Fig. 2 are useful for the relatively continuous type of coverage obtained with finely atomized sprays or roll coaters. Many applicators

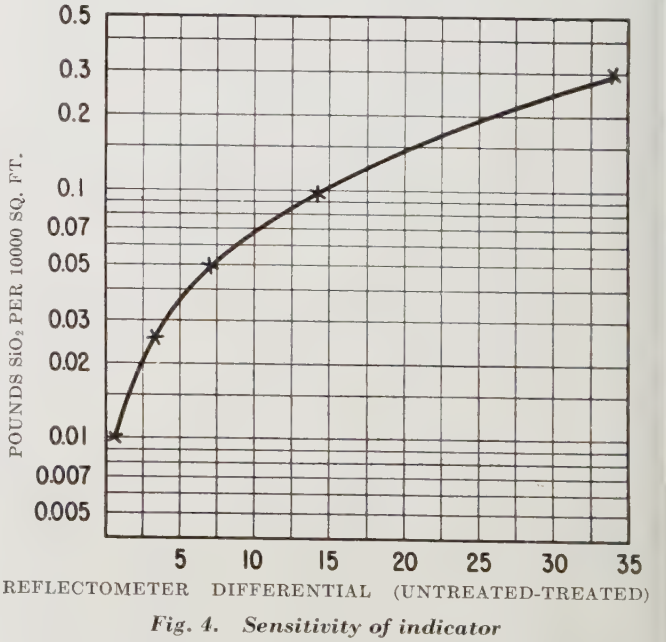


Fig. 4. Sensitivity of indicator

Photovolt reflectometer model No. 610 suppressed zero method. Dark standard, 6.5. Light standard, 45.0.

currently use coarse sprays. Figure 3 shows the type of colloidal silica deposit obtained with a coarse spray and the silica spread per 1000 sq. ft. of surface. It also shows that comparators can be constructed for coarse sprays, but they must be related to the number of droplets per unit area rather than to overall color intensity.

The combination of indicator and appropriate comparator becomes the long sought tool which enables the corrugator operator to know what he is doing when applying colloidal silica on the machine.

The sensitivity of the indicator solution is approximately 0.02 lb. of silica per 1000 sq. ft. This has been established from reflectometer differentials between the color responses produced by various levels of silica deposition and the untreated control. Figure 4 shows a curve that has been established for one set of treated kraft paper employing the Photovolt Reflectometer Model no. 610 and the "suppressed zero" testing method using a dark standard having a rating of 6.5 and a light standard having a rating of 45.0. For very precise research or development work, use of the reflectometer measurements would be valuable.

Cautions for the Use of the Indicator Solution to Assure Maximum Precision

Effect of Ultraviolet Light. The color intensity of standards may fade on exposure to light. Comparators should be kept in an envelope when not in use and new sets should be prepared about every three months.

Effect of Moisture in Paper. If the moisture content of common grades of liner is below 10% at the time the test is performed, there will be complete color development. At higher moisture contents on the test surface, the indicator will produce less than normal color intensity. If moisture content is above 10%, about 1 min. in a 110°C. oven is sufficient to produce satisfactory dryness for testing.

Effect of Nonionic Wetting Agents. When large amounts of nonionic wetting agents are present, (5–10% based on SiO_2) the indicator *cannot* be relied upon to develop the normal color. Since wetting agents may be used occasionally when colloidal silica is coated over oil base inks, this effect must be kept in mind in making comparisons.

Contamination. The effect of contaminating the liquid indicator with dried silica deposits from a paint brush or other applicator is relatively minor. However, it is recommended that users avoid dipping the applicator into the supply bottle or puring portions of the solution back. Occasional cleaning of the applicator in carbon tetrachloride or acetone is advisable.

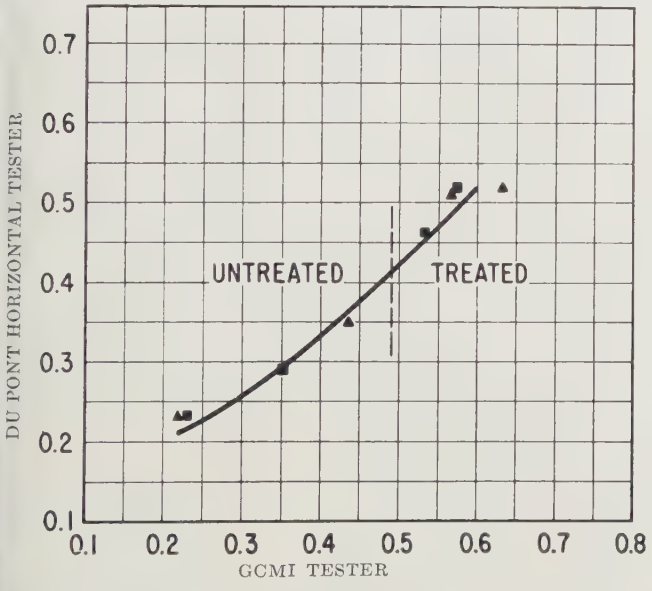
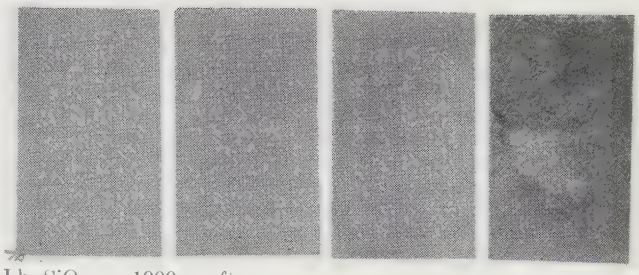


Fig. 5. Correlation of static friction coefficients on linerboard

▲ 42 lb. fourd. kraft. ■ 44-lb. cylinder liner.



Lb. SiO_2 per 1000 sq. ft.	None	0.05	0.1	0.3
μ_{static}	0.32	0.44	0.51	0.59
$\mu_{kinetic}$	0.24	0.35	0.48	0.54

Fig. 6. Relation between indicator color intensity and coefficients of friction at three levels of silica deposition

42-lb. fourdrinier kraft linerboard.

PRODUCTION CONTROL USING THE INDICATOR

As indicated earlier, the trial runs with fluorescent dye showed the problems in control of the application. Sampling was done across the full width of the machine at varying speeds from 200 to 500 f.p.m. Samples across the web showed widely varying amounts of silica deposition. It was found also that at a fixed flow rate an adequate application obtained at 200 f.p.m. was lighter at 300, just distinguishable at 400 and indistinguishable at 500 f.p.m.

Ortman-McCain then worked on spray systems that would give more uniformity of deposition across the web and with varying speeds. Uniformity across the web is controlled by the spacing of heads and the control of atomizing air pressure. While spray patterns are not yet perfect, much improvement has been made to the point where box performance tests are satisfactory.

The problem of variation with speed was attacked by installing two liquid systems each adjustable by needle valve, but one activated by a solenoid valve triggered by machine speed. A plugging switch driven from the corrugator drive shaft brings in the second liquid system when the speed exceeds 300 f.p.m. and cuts it out when the speed drops below 300 f.p.m.

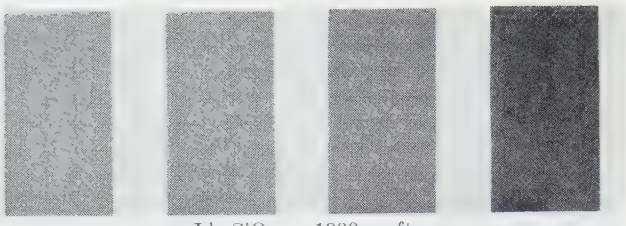
It was contemplated that a third liquid system would be installed if necessary. Present indications are that the two systems perform satisfactorily at speeds up to 500 f.p.m.

In summary, use of the indicator solution provides us with good insurance that effective amounts of colloidal silica are being applied.

MEASURING COEFFICIENT OF FRICTION

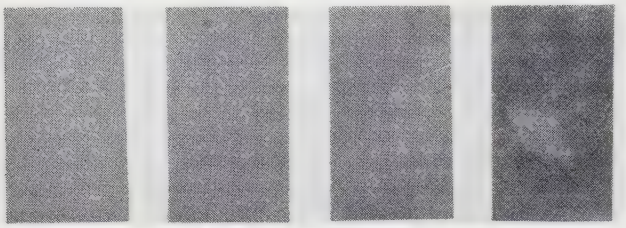
Any study of frictionizing effects must rely on the direct measurement of the coefficient of friction. A number of different methods are in current use. Some prominent methods utilize a horizontal plane and determine the force required to move two treated surfaces under a given load. This type of tester yields both static and kinetic coefficients. Representative examples of this kind of equipment include the Institute of Paper Chemistry (IPC) friction meter described by Apple (*2*) and the Glass Container Manufacturers Institute friction tester described by Turk and Maxson (*3*). Others utilize an inclined plane to measure the static coefficient of friction. Representative examples of this method include the Concora friction tester discussed by Long, Maltenfort and Taus (*3*), and a similar method discussed by McManus and Rother (*5*). Still other testers make use of the impact principle to produce comparative empirical results. An example of this is the well-known Conbur tester.

For the purposes of this study, two different horizontal



	Lb. SiO_2 per 1000 sq. ft.		
None	0.05	0.1	0.3
μ_{static} 0.28	0.49	0.52	0.65
$\mu_{kinetic}$ 0.23	0.41	—	0.63

A. 44-lb. cylinder linerboard.



	Lb. SiO_2 per 1000 sq. ft.		
None	0.05	0.1	0.3
μ_{static} 0.32	0.44	0.51	0.59
$\mu_{kinetic}$ 0.24	0.35	0.48	0.54

Fig. 7. Relation between indicator color intensity and coefficients of friction at three levels of silica deposition

B. 42 fourdrinier kraft linerboard.

type testers were used: (a) the GCMI friction tester, and (b) a du Pont made tester similar in principle to the IPC friction meter. Brief studies were conducted to determine a correlation between these two horizontal testers. The results of this study showing a fair correlation are summarized on Fig. 5.

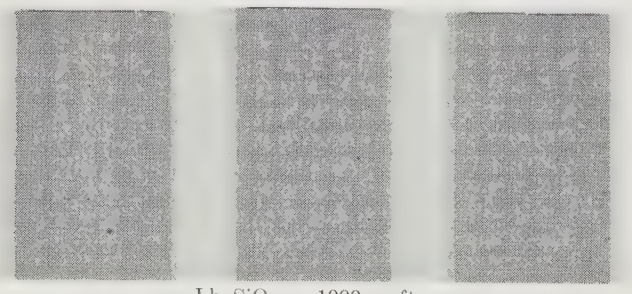
In view of the diversity of test methods used by the industry, more work of this kind needs to be done to guide the way to ultimate standardization for industry use.

CORRELATION OF SILICA DEPOSITION AND COEFFICIENT OF FRICTION

Thus far, we have discussed only the methods for determining the amount of silica deposited. To suit the ultimate purpose of the treatment, it is necessary to relate silica deposited first to the coefficient of friction of the treated board and ultimately to the performance of the treated box.

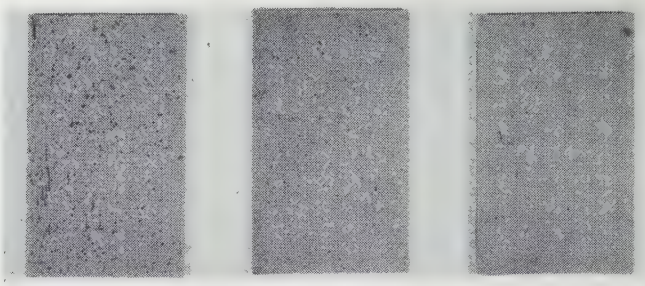
It was felt that the coefficient of friction of colloidal silica treated corrugated board is a function of at least three common variables:

1. The original coefficient of friction of the board being treated.



	Lb. SiO_2 per 1000 sq. ft.	
None	0.05	0.11
μ_{static} 0.25	0.49	0.64
$\mu_{kinetic}$ 0.21	0.46	0.60

Fig. 8. Relation between droplet frequency and coefficient of friction at two levels of silica deposition



	Lb. SiO_2 per 1000 sq. ft.		
μ_{static}	0.576	0.590	0.581
$\mu_{kinetic}$	0.545	0.523	0.507
	0.078	0.050	0.029

Fig. 9. Effect of fineness of atomization on coefficient of friction

2. The type of the board being treated.
3. The pattern of the colloidal silica deposit.

Utilizing any given sheet of linerboard, and any given method of application, a good correlation can be shown between the amount of colloidal silica present and the coefficient of friction.

An example is shown in Fig. 6 where we relate the measured static and kinetic coefficients to the color intensity developed by the indicator on 42 lb. fourdrinier kraft. These samples were treated to three levels of silica deposition using a finely atomized spray. As silica deposition is increased, both the color intensities and the coefficients of friction increase progressively. Figure 7 shows these same relationships for a surface-sized, 44 lb. cylinder liner treated to the same levels of silica deposition and compares it to the samples shown on the previous slide. The coefficients of friction of the treated cylinder liner are slightly greater per pound of silica deposited, even though the cylinder liner had a lower coefficient initially.

In a similar manner, correlations have been shown for coarse spray deposits relating the number of droplets per unit area to the coefficient of friction. An example of this is shown on Fig. 8.

The Effect of Fineness of Atomization on the Coefficient of Friction

The fineness of atomization can be varied on most sprayer installations. Corrugators wish to know which degree of fineness produces the best results. Figure 9 shows a range of droplet sizes obtained on an Ortman-McClain sprayer installation when the atomizing air pressure was varied between 40 and 75 p.s.i., with corrugator speed and liquid flow to the nozzles held constant.

The silica analyses reveal that the total silica deposition per unit area, however, decreases as the atomization becomes finer. This is thought to be due to the lesser ability of the smaller droplets to reach the moving board and results in increased overspray. Since the static coefficients of friction remain nearly constant in this series, it is concluded preliminarily that the use of fine sprays is more economical, provided the overspray is collected and returned to the supply tank.

Kinetic coefficients, however, do vary measurably with fineness of atomization, and there is an indication of a trend showing a preference for larger droplets. These observations have been made on several occasions, but need further confirmation before being considered firm.

Summarizing the findings on the correlation of silica add-on or spread and coefficients of friction, we conclude that color intensity or frequency of droplets, as revealed by the Indicator Solution, are reliable measures of coefficient of friction, provided that separate standards are constructed for each significant variation in the original coefficient of friction of the linerboard, the type of linerboard and pattern of colloidal silica deposits.

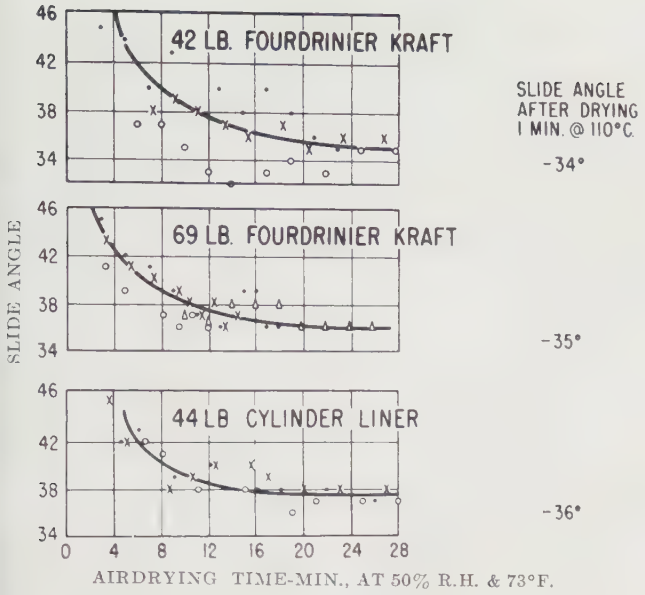


Fig. 10. Relationship between slide angle and drying time

The Effect of Moisture on the Coefficient of Friction

It is well know that the presence of moisture in paperboard can affect coefficient of friction markely. This may be very important both in research, control testing, and the final use of the package.

Studies were conducted in which representative linerboards were sprayed with 0.1 lb. of silica per 1000 sq. ft. and slide angles determined at various time intervals during drying. The results of this work are shown in Fig. 10 for 42- and 69-lb. fourdrinier kraft and for 44-lb. cylinder board.

These results show that after 15 to 20 min. airdrying at 50% R.H. and 75°F. coefficients of friction have stabilized at a constant value. All boards show a decrease from a much higher coefficient of friction value obtained immediately after spraying Other studies on these same boards show that the constant values for each can be achieved after ovendrying for 1 min. at 110°C. These findings point to a need to dry treated paper before making friction tests directly off a machine.

The question has been raised as to whether colloidal silica treatments on paper are adversely affected by low temperature or low humidity. A series of tests was run over a range of temperatures and humidities in an attempt to answer this question. Table I summarizes this work.

A comparison of measurements 1 and 4, both made at low relative humidity, indicates that temperature alone has no significant effect on the static coefficient of friction of colloidal silica treated paper. The data from measurements 1, 2, and 3 show a substantial drop in coefficient of friction as relative humidity is decreased from 88 to 50%. Below 50% R.H. the effect is minor.

The most significant conclusion drawn from these data is that increases in coefficient of friction due to treatment with colloidal silica remain essentially constant regardless of relative humidity or temperature conditions.

Table I. Effect of Temperature and Humidity on Static Coefficient of Friction

42-lb. Fourdrinier kraft linerboard treated with 0.1 lb. per 1000 sq. ft. of colloidal silica

Storage and test conditions	*Static Coefficients of Friction* — *Water-treated controls*	*Silica treated*	*Increase*
85°F., 15% R.H.	0.47	0.69	0.22
75°F., 50% R.H.	0.53	0.71	0.18
78°F.. 88% R.H.	0.73	0.93	0.20
− 5°F., 0% R.H.	0.47	0.71	0.24
− 5°F., Refrigeration conditions (% R.H. unknown)	0.50	0.74	0.24

END-USE PERFORMANCE

The relationship between coefficient of friction of treated board and the antislip requirements of containers varies with use conditions so widely that it is difficult to generalize. However, experience so far indicates that significant improvements in antislip performance result if antislip treatments increase the coefficient of friction 0.2 to 0.3 or increase the slide angle 10° to 15°.

SUMMARY

A tool is now available in the form of an easily applied indicator to show the corrugator operator the amount and distribution of silica which he is putting on his board. Improvements have been made in spray applications using the indicator as a measurement tool, particularly in the problem of variation with speed. This tool should be equally valuable in the control of roller applications. Coefficient of friction tests have substantitated the reliability of the indicator as a measure of silica deposition and consequent increase in antislip characteristics.

Like any valid study, this one points to areas where more work needs to be done, such as:

1. Relating the coefficient of friction to box performance during handling, warehousing and shipping.
2. Correlation of various laboratory testing devices for measuring coefficient of friction and box performance.
3. Greater understanding of the relative cost and operational advantages of various available application methods.

LITERATURE CITED

1. McEwan, G. J., Beimler, R. P. Kaelble, E. F., and Taulli, T. A., *Tappi* 42, No. 9: 776–779 (Sept., 1959).
2. Apple, W. W., *Tappi* 41, No. 5: 151A–152A (May, 1958).
3. Turk, J. G. and Maxson, R., *Tappi* 38, No. 5: 161A (May, 1955).
4. Long, F. D., Maltenfort, G. G., and Taus, R. G., *Fibre Containers and Paperboard Mills*, 72–75 (March, 1959).
5. McManus, A. R. and Rother, R. J., *Package Engineering*, 4 No. 2: 31–35 (Feb., 1959).

Received Mar. 21, 1960. Presented at the 45th Annual Meeting (Corrugated Containers II) of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

The authors wish to express their sincere appreciation to L. S. Johnson of Cornell Paperboard Products Co. and T. J. Desmond of Du Pont for their interest and for the contribution of valuable suggestions throughout these studies; to W. Placzankis of Du Pont for active participation and liaison; to R. L. Rusher, W. L. Turner, and T. D. McGowan of Du Pont, and to R. H. Robinson of CornellPaperbord Products for the research and testing work necessary to make this contribution.

Special acknowledgment is due L. W. Ortman of Ortman-McCain for his many contributions to this study.

Production, Progress, and the Manufacturer's Joint

JEROME J. KIPNEES

Packaging in the United States has undergone a remarkable transition in the past two decades. Unquestionably, future historians will refer to the age we live in as the era of packaging revolution. Prominent economists contend, and quite justifiably, that the packaging industry today is truly the pulse and the barometer of our national economic well being. Packaging prominence has been generated by a variety of factors, the most noteworthy being American ingenuity and productive skill. Other stimuli have been World War II, the Korean hostilities, the significant population expansion and modern industry's acceptance of packaging as an important marketing, merchandising, and selling tool.

Jerome J. Kipnees, Vice-President—Package Engineering, Atlantic Gummed Paper Corp., Brooklyn, N. Y.

The packaging industry has responded to this multibillion dollar challenge with the introduction of packaging materials, methods, and equipment literally unheard of 20 years ago.

In materials alone, consider a packaging industry without plastic packaging films such as polyethylene and the vinyls; without plastic cushioning materials such as polyurethane and polystyrene, devoid of such materials as glass, rayon and nylon fibers, packaging foils, extensible paper, molded pulp, aerosol packaging, pressure-sensitive packaging tapes, reinforced gummed tapes, aluminum cans, corrosion inhibiting agents, etc. All of these materials have contributed substantially to the progress of the packaging field.

In methods we have seen remarkable advances in unit load handling, palletizing, reinforcing, and bundling. We have witnessed the development and refinement of easy-opening and dispensing features, nonskid applications, efficient coatings and laminations, and a host of labor-saving procedures.

In equipment we have seen the introduction of devices for blister packaging heat, sealing, product loading, case sealing, sorting, coding, labelling, etc., and the refinement of mechanical devices for both the production and utilization of packaging materials and methods.

The paper and paperboard industry can also point with pride to its own important contributions furthering packaging science. The past 20 years has seen the introduction of C-flute corrugated board, the transition in large part to semichemical medium, the introduction of triple-wall corrugated fiberboard for heavy duty industrial packaging purposes, weatherproof corrugated fiberboard, outstanding improvements in printing, surface design and display features and the utilization of many different additives in the form of coatings, impregnations and laminations, designed to improve fiberboard box performance.

Consistent with these packaging developments, manufacturers joint improvements have kept pace with the demands of progress and the ever-present requirements of lower cost, increased performance and adaptability to higher production speeds. Joint improvements have been advanced in all three major areas of packaging activity namely: materials, methods, and equipment. As a result of this progress, the convertor and the ultimate box user have been provided with a wider range of joint constructions thus permitting greater selectivity in consideration of end-use and performance applications.

Not too long ago, the most popularly used manufacturer's joint constructions consisted of metal stitching and taping with either cambric or clay-filled cloth tapes or asphalt-laminated tapes having a random sisal fiber reinforcement. The cloth tapes were costly and the reinforced sisal fiber tapes were both erratic in performance and subject to fiber procurement difficulties. In today's converting operations, cambric and clay-filled cloth tapes are only seldom used and laminated joint tapes having random fiber reinforcement have been entirely replaced by a modern joint tape characterized by accurately spaced inorganic fiber reinforcement. In recognition of the stresses applied to a joint in field usage, and to facilitate tape application in the convertors' plant, joint tapes are ordinarily constructed with bidirectional fiber reinforcement. Further, the taping industry has selectively experimented with glass, nylon, and rayon to achieve optimum fiber performance in view of the varying characteristics of these inorganic fibers with respect to tensile strength, impact resistance and elongation properties.

The type of fiber employed, the weight of fiber and frequency of spacing used in todays modern reinforced joint tape are contained in detail in the provisions of section 11 of rule 41 of the Uniform Freight Classification along with glued and stitched joint construction requirements.

In addition to the significant changes in fibers and fiber orientation, the tape industry has made available both asphaltic and nonasphaltic laminants, and has greatly improved the gumming applied to paper to insure the compatability of taping with modern, high-speed converting operations. The development of high-speed tape application equipment has greatly enhanced the efficiency of joint fabrication.

A significant change in joint construction occurred in December, 1949, when glued lap joint construction was authorized by rule 41. Significant usage of the glued lap joint is only relatively recent and has been generated by the parallel development and introduction of new automatic and semiautomatic machinery and suitable adhesives for use on these machines.

Stitched joint modifications during the period of time under review have been less dramatic but nevertheless have included important changes in the gauge and contour of the wire, treatment of the metal and in the equipment used in joint fabrication.

Prior to developments of the past 15 to 20 years, it was believed generally that the manufacturer's joint was the weakest element of the engineered structure represented by the finished box. However, this statement is far from true now. In my own personal experience, which has involved the study of many thousands of performance tests on loaded boxes—tests simulating both normal handling and tests run to destruction—that almost always other portions of the box failed prior to joint rupture. These other portions involved the box scorelines, generally the horizontal but occasionally the vertical scores, the panels and occasionally the flap closures. Of course, this phenomenon whereby the manufacturer's joint is less vulnerable than other box parts will not prevail for all types of loads and for all types of joints. On the other hand, there seems to be sufficient evidence to indicate that the relative indestructibility of the manufacturer's joint applies to many containers where the load either does not bear directly against the vertical edge at the joint or is so light that it sets up relatively innocuous stresses.

The packaging technician and the convertor have both realized that there is no absolute relationship among the three types of joints—taped, stitched, and glued—and that selection of the optimum type depends upon the particular packaging problem involved. The latter should entail considerations of such factors as the certificate grade of the box, the size and shape, the nature of the contents, the type of filling operation employed, the details as to storage of both KD and filled containers and the details of handling and shipment. This is the nature of approach which should be employed in the determination of the joint construction to be used. However, the problem is also complicated by the fact that there should be two prime considerations: functional effectiveness and cost. Joint cost is influenced by such factors as the dimensions of the container, particularly the depth, the quantity of the order and the type of equipment used for the finishing operation.

While the importance of relating the requirement of the individual packaging problem to the determination of the optimum joint has been stressed, there are several broad generalizations which may be helpful. In the first place, we have indicated, that for the great majority of corrugated fiberboard boxes, the manufacturer's joint is less vulnerable to the hazards of handling, storage, and shipment than other portions of the container. For containers of this sort, it is obvious that the type of joint which is superior from the standpoint of KD stacking and cost would be preferable. From the users' and convertors' point of view, other broad generalizations of manufacturers' joint characteristics apply. For example, a taped joint does not have the overlap characteristic of stitched and glued constructions. The latter two types may therefore, be at a disadvantage in the storage of KD containers unless crushing of the overlap and the adjacent area of the blank is carried out. Extreme care must be exercised in this operation to prevent significant loss in box performance, notably in stacking strength. It is only fair to mention that

the crushing of the overlap can be successfully performed these days, particularly with glued joint containers.

Taped boxes and glued and stitched boxes with the tab on the outside do not permit utilization of the full panel area for printing. On the other hand, when glued and stitched boxes have the overlap or tab on the inside they may interfere with the fit of the packages within the box. Obviously, this latter point depends on the shape of the interior containers and would not apply, for instance, to round cans. Further, stitches can cause injury to personnel in hand filling operations and can cause scratching or puncturing in unit containers within the box if the stitching operation is not carried out well.

Both taped and glued joint containers are dependent to a certain extent upon the adequacy of the bonding of the corrugating material to the facings for proper performance of the container. By way of illustration, the manufacturer's joint with either of these two types might itself be perfect but if the adhesion between the corrugating material and the inner facing is imperfect, there may be a separation of these elements in the body of the container. This would be more serious with glued joints where the glue tab was on the outside; the inner facing of the tab could be effectively bonded to the outer facing of the adjacent area of the blank but the outer facing of the tab-with or without the corrugating material-would be free to peel away along the perimeter of the box if the bonding were poor. Such a condition would be prevented by stitching since, to use a single-wall box as an example, properly formed and applied stitches grip all six elements—the four facings and the two corrugating materials.

Another potential weakness of both glued and stitched joints when the overlap or tab is on the outside is the possibility that these tabs will catch or snag on objects such as the outside joint tabs of other containers, posts, projections in car walls, etc.

Boxes with stitched joints provide for easier inspection where the joint is concerned, than those with taped or glued joints, particularly the latter. It can be more readily determined from visual examination whether the required number of stitches has been applied and whether they have been clinched properly than to determine whether the full area under the tape or under the glue tab is bonded.

All of the above general factors should be considered by the convertor in the selection of the particular joint construction to be used. The factor of relative cost in most instances can be discounted in joint selection. Whereas tape cost per inch of depth of the container is higher than the stitching wire or glue cost, the cost differential is generally counterbalanced by the extra square footage required for the lap on glued or stitched boxes.

Many individuals have expressed interest in the relative importance of taping, gluing, and stitching as methods of manufactuer's joint closure of corrugated boxes. While up-to-date figures on all closures are not currently available, some rather interesting data can be presented.

A large scale survey conducted in March, 1957, disclosed that 53% of all boxes were taped, 31% were stitched, and 16% were glued. The survey, which was a compilation of converter questionnaire responses, also attempted to anticipate future usage and it was then projected that taping would remain about half of the total with the remaining utilization shared approximately equally by stitching and gluing. While current overall joint utilization figures are not available it may be interesting to examine tape joint statistics. It is significant to note that since 1957 joint tape utilization has increased more than 10% and this figure essentially parallels the growth curve of the fiber box industry in the comparable period.

However, like the available flute constructions of A, B, and C, all three joint constructions—taped, stitched, and glued will continue to enjoy their share of utilization, largely on the same basis motivating flute selection—and that is suitability to the given packaging application.

The problem of proper joint selection is becoming increasingly important today with the extension of corrugated fiberboard packaging into new fields of application. Corrugated packaging has been extended to a broader range of industrial application and has undergone the esthetic transition imposed by greater emphasis on marketing and appearance.

The problems faced by corrugated packaging in these new areas are also shared by those who produce the materials available for joint construction. In the tape industry this awareness has led to continuous experimentation with new adhesives, laminants, and fibers designed to meet not only new performance requirements but production requirements as well.

While crystal-ball gazing into the future is more appropriately in the bailiwick of the prophet, it is reasonable to assume that the manufacturer's joint of the future will be subject to further modification. It is conceivable that future developments will entail a successful combination of current and new materials to produce a joint construction which provides an even greater degree of strength permitting far greater speeds of application and available at lower cost.

Certainly the many new plastic materials will be investigated and it is possible that the joint of the future may even be heat sealed to become a more integral part of the container. Improved papers will be studied, not only to overcome the problem of delamination of paper stock due to poor internal fiber bond, but to provide for greater esthetic appeal. It is possible that laminated tape structures may be largely replaced in the future by a single sheet incorporating new and greater strength fibers providing for maximum strength at lowest weight and cost.

While all those developments are still only approaching the blue print stage, the convertor can be assured that joint developments will closely parallel and complement his own unlimited explorations into the future of packaging.

Received March 21, 1960. Presented at the 45th Annual Meeting (Corrugated Containers II) of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Sources of Errors and Practices Contributing to Their Reduction

W. J. HURRELL

It would be an impertinence for me, in the presence of this distinguished audience, to suggest that I could offer any panacea or magic formula that will eliminate errors in the corrugated plant. However, the complaint investigation procedure that I am going to discuss has greatly reduced the number of errors occurring in our plant, and has assisted us in improving the morale of our employees and in upgrading the quality levels of our product.

The comments that I am going to make, of course, may not apply equally to other corrugated plants, but I am sure that if you are prepared to put the necessary time and effort into the investigation of errors in your plant, you will be very gratified and even amazed with the results.

Webster's dictionary defines an "error" as something incorrectly done through negligence or carelessness, a mistake, a wrong belief or an incorrect opinion.

Our experience has indicated that the vast majority of errors are caused by "incorrect opinions," wrong beliefs or by a "mistake" on the part of a clerk or machine operator. Relatively few are due to outright negligence or carelessness.

For the purpose of this talk I would like to consider any departure from established standards or customer specifica-

W. J. Hurrell, Hinde and Dauch Paper Co. of Canada, Ltd., Toronto, Ont.

Customer Complaint Report No. 102

Make this report on all complaints whether any adjustment required or not.

Salesman's Report

Customer: King Meters Limited
Order no: A-5193 Quantity shipped: 1,000
Box no.: 49W Date shipped: July 6/59
Contents: 4 gas meters

Nature of Complaint

Give full particulars, number of defective boxes, short shipments, etc. If complaint involves defective boxes, sample must be attached.

Boxes imprinted "KING METER LIMITED" on two side panels instead of "KING METERS LIMITED." New dies—first printing.

What Adjustment is required or recommended?

Order to be replaced.

Date: July 9, 1959 H. O. Evans, *Salesman*

Plant Manager—Factory Report and Recommendation
Indicate which department responsible.

The responsibility for this error rests with the Printing Department supervisor who perpetuated a mistake made by the die manufacturer.

Date: July 12, 1959 A. J. Brown, *Plant Manager*

Sales Manager—Action Taken (Credit, if any, etc).
Indicate which department responsible.

Order has been replaced to the customer's satisfaction.

Date: July 16, 1959 D. A. Johnston, *Sales Manager*

Fig. 1. This customer complaint, originated by the salesman because of the omission of the letter "s" from the word "Meters," has been answered by the plant manager and commented on by the sales manager

Factory Error Report No. 85
(Customer Complaint No. 102)

Customer: King Meters Limited
Schedule data: June 30, 1959 Order No. A5193 Quantity 2,000

Nature of Error

Boxes imprinted "KING METER LIMITED" on two side panels instead of "KING METERS LIMITED." New dies—first printing.

Where Did Error Originate?

Printing Department.

Signed: H. Murray Coordinator Department

Report of Department Foreman as to Why Error Occurred

Run on machine no. 225

By operator: C. Dixon

The missing letter "s" was not noticed by the Die Mounting Department or by the printer slotter operator and I failed to catch it when I okayed the order.

Corrective Action Taken

The printer slotter operator C. Dixon has been verbally warned to check printing dies before setting up.

I will be more careful in okaying orders in the future.

Signed: L. S. Greene Printing Department

Superintendent's Comments

This error is the responsibility of the Printing Department supervisor.

Signed: T. L. Mills, *Superintendent*

Fig. 2. This report was originated by our coordinator to investigate the customer complaint shown in Fig. 1. The printing department foreman has answered the complaint and the superintendent has commented on the action taken. A copy of this report will then be attached to the complaint and returned to the salesman

tions as an "error." The constantly increasing tempo of business in our industry has brought with it increased demands for faster delivery, more complex printing, intricate die cutting and more rigid customer specifications. As a result, we have been plagued with an increase of errors out of proportion to the increase in the total number of orders produced. Each of the hundreds of thousands of orders we process must have its own individual specifications, printing instructions, printing dies, and cutting dies, each covering some particular phase of the production operation.

We have tried to outdo each other by processing these instructions and manufacturing and delivering the corrugated product within days and sometimes within hours. No one from the salesman to the shipping clerk has had the extra few minutes required to re-check specifications or instructions or to make the final adjustments necessary on the printer slotter to ensure a product acceptable in every way to the customer. Consequently, inaccuracies have crept in and these have resulted in customer complaints and rejected boxes.

CUSTOMER COMPLAINT

The somewhat formalized complaint investigation procedure that we now use in Toronto was the outgrowth of the conventional customer complaint report shown in Fig. 1. This complaint form was originated by one of our salesmen whenever a problem arose with a product we had delivered to a customer or when we failed to meet a promised delivery, and indicated the adjustment or action that, in the opinion of the salesman, would be required to retain the goodwill of our customer.

The thorough investigation of these customer complaints soon indicated that there was much more to the problem than was immediately apparent, and that the fault did not all lie with the people who ran the machines on the factory floor. Too often these complaints tended to show one side of the story only.

FACTORY ERROR REPORT

We, therefore, developed a "factory error report" with a twofold purpose. First, to give the supervisors and employees accused of making the error an opportunity of presenting their side of the story and secondly, to enable management to ensure that corrective action had been taken to prevent a repetition. This form was used to investigate any customer complaint that appeared to be due to factory error, as shown in Fig. 2.

The same procedure was used to investigate the complaints of one production department against another production department, as shown in Fig. 3. Any supervisor has the right to originate a factory error report whenever he has a serious problem due to the failure of some other department to produce an acceptable product. However, we did not insist on a factory error report unless the cost of the rejected material exceeded $50.00.

Factory Error Report No. 20

Customer: D. C. Glass Company Limited
Schedule date: October 9, 1959 Order no: C5432 Quantity: 2,000

Nature of Error

Panel score cut right through sheet—200 boxes rejected.

Where Did Error Originate?

Printing Department

T. R. Allan, *Supervisor* Finishing Department

Report of Department Foreman as to Why Error Occurred

Run on machine no. 225

By operator: L. Jones

These boxes were shown to Jones and crew and they were verbally warned to be more careful. They claim that scoring shaft is not level.

Corrective Action Taken

Work order issued to Maintenance to have shaft checked.

A. J. Howard, *Supervisor* Printing Department

Superintendent's Comments

The scoring shaft has been adjusted.

Signed: T. L. Mills, *Superintendent*

Fig. 3. This factory error report was originated by the finishing department supervisor because of faulty scoring on an order received from the printing department. This has been answered by the printing department foreman and commented on by the superintendent

Procedural Complaint No. 35

Customer: A. P. Blackhall & Son
Order no: C-5298 Quantity in order: 3,000
Box no: F-59W Scheduled date: Aug. 9/59

Nature of Complaint.

Give full particulars, number of defective boxes, explanation of error, copy of shop order, dollar loss, etc.
Attach a sample of the box, shop order or printing instruction if necessary.

Printing instruction calls for two colors—a specification sheet calls for one color only.

What Action is Required or Recommended

Check specification sheet.

Date: August 12, 1959 R. C. Smith
Die Mounting Department

Sales Department Report and Recommendation
Indicate Department responsible.

Specification sheet wrong—has been corrected

Date: August 15, 1959 J. C. Richardson
Department Head

Note Further Action Required

Action satisfactory.

A. J. Brown
Plant Manager

Fig. 4. This complaint was made by the supervisor of the die mounting department because the specification sheet and printing instruction did not agree. The department head responsible for the error has made the necessary correction and the plant manager has satisfied himself that the action is satisfactory

CAUSES OF FACTORY ERRORS

We found that out of every four errors investigated during the first three months three were due to inaccuracies in or misinterpretation of some specification or instruction. Our communication system had failed either because we were not providing clear instructions in the first place or because we had not trained our employees to properly interpret these instructions and specifications.

Our experience has since proved that we had been greatly overemphasizing those errors made by the machine operators during the manufacturing process. The return of an order by an important customer because of a poor printing job or because one of the dimensions was wrong has usually caused all of us in management to see red and to demand the scalps of the guilty individuals. However, we are prone to accept clerical or procedural errors resulting in the same number of rejected boxes and an equal dollar loss as the price of doing business, and do not get particularly upset.

Possibly our failure to "do something about" the error that occurs in the office during order preparation is because the responsibility is spread over a number of people or departments and we are not always prepared to take the time required to thoroughly investigate the problem. Consequently, we fail to take the necessary corrective or disciplinary action, and allow the error to reoccur.

Repetitive errors are frustrating to the customer, the salesman and the production manager alike. I am sure we can all think of examples, such as the one that occurs after our salesman has talked his customer into accepting an order that we did not make according to specifications—possibly with the wrong color of ink—and then find that the next order run two weeks later was again run with the wrong color because someone never got around to changing the instruction to the printing department.

PROCEDURAL ERRORS

It seemed to us that this factory error report was effectively covering all of the problems that were arising *after* the instructions and specifications for the order were placed in the hands of the production department.

We, therefore, decided to include in our investigation all the clerical or procedural errors occurring during the preparation of these instructions and specifications *before* they were given to the production department and developed the form shown in Fig. 4.

Any of our supervisors finding an error in the specifications or instructions he has received immediately fills in this form and originates this procedural complaint.

During the first month this phase of our program was in operation we processed more than three procedural complaints for each 100 orders manufactured.

Obviously this interdepartment error investigation plan takes a lot of work and must have the complete backing of plant and sales management. To be successful, each department head must be prepared and willing to take the time and exert the effort necessary to ensure that each error or complaint is answered to the satisfaction of the person originating the report.

COMMUNICATIONS AND CORRECTIVE ACTION

We have a coordinator in our plant who divides his time between waste reduction, error investigation, and accident prevention. These functions have much in common.

We believe that accidents are caused by unsafe acts or by unsafe conditions and that most unsafe acts occur because

some employee was not adequately trained in the proper methods of performing the job. Similarly, we believe that errors are either attributable to insufficient or incorrect information or to an incorrect action on the part of some employee. Normal employees do not want to have accidents nor do they want to make errors.

To ensure correct information we should establish an effective communication system that will provide our employees with clear, concise instructions and pictures or drawings to describe intricate or complex specifications. To prevent incorrect action on the part of our employees we must train them so that they will be able to properly operate our equipment and to understand the terminology and specifications we are going to use to describe our products and to set up and make ready our machines.

A good part of the problem of communications has been, I think, due to the unwillingness of many of us who have been in this industry for many years to realize that after constant association the complex becomes commonplace. The specifications and instructions that are simple to us are very complex to someone who has not had the necessary basic education or the opportunity to familiarize himself with them.

As a means of our promoting these programs we hold weekly waste reduction meetings with our supervisors and semiweekly safety meetings with supervisors and inspection groups. Training courses in interpretation of specifications and proper equipment operating procedures, along with contests stressing employee participation and first-aid courses, are also used to publicize these projects.

Examples of defective products or of customer complaints, along with pictures of unsafe acts, potential accident hazards, or conditions that might create waste, are regularly posted on Department bulletin boards by our coordinator. Graphs and percentages indicating our weekly and monthly progress in accident prevention, waste reduction, along with other pertinent data are also posted on these bulletin boards. We are careful to obliterate the names and blank out the faces of those employees responsible for errors or unsatisfactory conditions, thus avoiding any possible resentment that might ensue.

We also use the "positive" approach and post examples of particularly good workmanship and pictures of employees winning any of the contests that we run monthly. We must, of course, be prepared to take disciplinary action against the employees responsible for errors, if such is indicated.

If either of the reports shown in Figs. 2 and 3 had indicated that the error had been due to gross carelessness or negligence on the part of the employees concerned, the supervisor answering the complaint would have been obligated to take disciplinary action. This action might, depending on the seriousness of the offense, involve a verbal warning to the employees responsible or it might be a written disciplinary warning with copies to the employee and to our labour union. In rare instances, the investigation of the error has resulted in the dismissal of the employees responsible.

Close adherence to this procedure will ensure that corrective action will be taken, regardless of whether the error was caused by negligence on the part of an employee, a mechanical failure in the equipment, or a problem with one of the raw materials being used. As you will note in Fig. 3, the supervisor has stated that a mechanical defect caused the error and the work order has been made out to the maintenance department covering this defect.

If it is deemed advisable by the coordinator, the factory error report covering the original customer complaint will be returned to our sales department, along with our answer. This report will enable our salesman to give our customer positive assurance that we have taken action and intend to avoid a repetition of his complaint.

This complaint investigation procedure as outlined above has given each of our supervisors in the plant and in the office an opportunity of suggesting ways of improving our order processing methods and of clarifying instructions.

SUGGESTED RULES

Providing that certain basic rules are followed, this plan will gain ready acceptance by everyone—supervisor, employees, and labour union alike. We believe that it is essential that everyone recognize:

That the prime purpose of this error investigation procedure is to avoid any repetition of the error, not to embarrass anyone or to make a scapegoat of any particular individual.

That the prime responsibility for the error rests with the person who had the last clear opportunity to prevent it. Of course, this does not, in any way, relieve others of their rightful responsibility for the parts they played in the circumstances leading up to the error—i.e., the foreman of the printing department must take full responsibility for the printing of an order with an incorrectly spelled word. However, the printing die manufactuer and the die mounter must each assume responsibility for their parts in making and mounting an incorrect printing die.

That no blame will be specifically laid at anyone's door, unless it is definitely established that the error was due to carelessness or neglect on the part of that person or that crew.

That this investigation procedure is a two-way street. Each supervisor required to answer complaint reports must have the right to make out complaints covering errors originating in any other department of the plant and must have the right to satisfy himself that suitable, corrective action has been taken.

That each supervisor and employee have a clear understanding of the quality levels that he is expected to maintain and of the procedures he must follow when he is unable to meet these quality standards. Employee morale will suffer if we criticize anyone for a problem or mistake they did not know how to avoid.

STATISTICS

In a recent 12-month period we shipped 29,496 individual items, totalling approximately 570,000,000 sq. ft. and processed 340 complaints covering errors occurring *before* the production department received the order. This represents a reduction of more than two-thirds in the number of this type of error occurring since the inception of our complaint procedures.

One hundred and thirty-three customer complaints were also investigated during this period: 75 were due to errors occurring during production operations, 29 because of failure to ship as promised, and the balance due to faulty materials, procedural errors, and miscellaneous. We also processed 74 complaints originating in one production department against another production department because of rejections of off-quality product causing serious production problems.

Some of the items covered by the above complaints were of a very trivial nature. Each, however, was thoroughly investigated and answered to the satisfaction of the salesman or supervisor originating the report.

CONCLUSIONS

This complaint investigation procedure has enabled us to drastically reduce the number of procedural or clerical errors occurring in our office and to minimize the number of complaints received from our customers.

The reports covering these errors and complaints have provided us with a very effective managerial tool and by indicating the problem areas in our plant and office, have assisted us in improving our customer relations and in controlling the quality of our product.

The processing of a complaint or error report in itself provides a very salutary effect on the supervisors and employees concerned, and to a considerable extent reduces the need for

disciplinary action by management. No one likes to spend time thinking or talking about a mistake he has made, even less reporting how he is going to avoid making it in the future.

The impartial application of this complaint procedure has forced all our people to realize that they are all in the same boat and that the grass is not necessarily greener on the other side of the fence. Consequently, the barriers that sometimes seem to exist between office and plant, between sales and production, have been largely removed, with a resultant improvement in employee morale. The adoption of this procedure is, in itself, of course, not the complete answer to the elimination of errors.

Equally important is the standardization of the specifications and terminology peculiar to each company or plant, and the simplification of complex specifications or intricate printing instructions by the use of drawings or by Xerox or other types of photography. All plant and office personnel having occasion to use specifications must be trained in their interpretation.

Finally, and perhaps most important of all, production personnel must be trained in the correct methods of operating their equipment. The importance of and the benefits to be derived from the preparation of operating instruction manuals to cover each operation in the plant and on-the-job, or job instruction training for each of our operators cannot, in my opinion and based on our experience, be overemphasized.

Received March 21, 1960. Presented at the 45th Annual Meeting (Corrugated Containers II) of the Technical Association of the Pulp and Paper Industry, held in New York, N.Y., Feb. 22–25, 1960.

Corrugated Containers Session III Proceedings

Corrugated Containers Session III of the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held at The Hotel Commodore, New York, N. Y., convened in the Grand Ball Room at 2:10 p.m. on Wednesday, February 24. Dave C. Dowd, Specialty Equipment Corp., opened the meeting.

Mr. Dowd: Gentlemen, we're about to begin the third and final phase of the program. I believe this year is the first time we have had a forum and question-and-answer period of this particular type.

In keeping with the realities of the production merry-go-round and the variables, Tikie Scordas, of Union Bag-Camp Paper, has come up with a very unique idea, and we're looking forward to the results of such a session.

Here at the panel we have a group of distinguished gentlemen, whom through the years I am sure you all know more and more on a person-to-person basis. Accordingly, Tikie has arranged a very outstanding program, and at this point it is my pleasure to turn the program over to Tikie Scordas, of Union Bag. Thank you.

Moderator H. T. Scordas: Thank you, Dave.

I'm delighted and honored to have the unsung heroes of Corrugated today on this panel, the service personnel of the leading manufacturers of corrugated equipment. Actually, these people represent a good many of you who are among us who are with other companies.

As an example, the starch people have their own service personnel. I could name two dozen of them right offhand, fellows like Paul Spenadel, Ray Riding, Bob Sherman, Jim Goldring; but today we have, as we said, the service personnel of the corrugating machinery manufacturers.

On my right is Al L'Esperance, of S. & S. Al has 20 years' experience in the service part of the corrugated industry. Next to Al is Joe Dunch. Joe is with Swift. He's had 16 years. And immediately on my right is Bill Schroeder, and Bill has had 32 years of service experience. So, gentlemen, that adds up to 68 years.

On my left is Nick Feretic, of S. & S., with 14 years' experience in service. To his left is Les German, of Greenwood, with 14 years' experience. And on his left is Denny Shanahan, 36 years with Koppers.

Gentlemen, that adds up to 64 years.—I failed to mention that Bill is with Langston.

Gentlemen, we'll have a few ground rules, and one of them is this. These people aren't up here to give a sales pitch, so definitely you have got to help us by not asking leading questions on why Langston has something that somebody else doesn't have. I think that, really, there are so many questions of a general nature that we could keep this thing going on for weeks.

Now, you can either write your question on a sheet of paper and pass it to the people who have the microphones, or else you can get up. If you want to identify yourself, that's perfectly all right. Ralph Buttery has a microphone. Stand up! Let's take a look at you. Keith Provo has a microphone, and Bob Jenks has a microphone.

Gentlemen, will you be sure, before you ask the question, that you have been given the microphone. You can hold up your hand; because we have a stenotypist who will take down the questions and also take down the answers, and then these will be available to you by signing this sheet of paper that identifies you, and you send in $4 or $5, depending upon whether you are a TAPPI member, and the whole session will be in print, and I think it's a wonderful idea of TAPPI's, and I certainly appreciate the effort that they have gone to.

Now, as was stated before, this question-and-answer period is going to be on operating and maintenance problems of corrugating and cutting, and we have a big field to go over, so we can start right now. Who has the first question?

Question: What can best be done to prevent buckling of a box adjacent to a body score, when it's folded on a folder-taper machine?

Moderator Scordas: Whom would you like to have answer that?

Question: An S. & S. man.

Mr. Feretic: What was that question again, sir?

Question: When a box is folded on a taper, at times the box buckles just adjacent to the body score.

Mr. Feretic: Well, that can be due to a creaser that is flattened out, and instead of creasing between the corrugations it may crease off the corrugation. If you have your crease fall-in right in the flute, then you are going to get a good, square box, but sometimes it creases off to one side, and that's where your box goes crooked.

Question: At one time you used to have thinner rolls on the machine than I believe you have now. Can you install thinner rolls, or bevel the roller in order to help the situation in some way?

Mr. Feretic: Do you mean the creaser shafts on the machine?

Question: No, I'm talking about the flat rolls.

Mr. Feretic: That's a folded taper?

Question: Yes.

Mr. Feretic: I'm not too familiar with a folded taper.

Question: Is there anybody else up there that can answer that?

Moderator Scordas: How about the scoring of that?

Mr. Feretic: The scoring on the printing press? We increased the diameter of the shaft, because we had a certain amount of whip in that shaft, and we increased the shaft $^3/_8$ in., and made a tubing instead of a solid shaft, and that helped the box a great deal. That's about all I'm familiar with on that.

Comment: I'd like to suggest what you might be talking about, if you have three possible scores. You could possibly make three scores, and might break in in any one of them, if it gets down too low.

Mr. Feretic: On the creaser shafts, if your shafts aren't

parallel, you will be creasing more on one side than the other. That would cause a problem also.

QUESTION: We try to make it very accurate on the cutoff beam, but what could be done to make it really accurate?

MODERATOR SCORDAS: Bill, would you like to answer that?

MR. SCHROEDER: Do you have greasy belts?

QUESTION: We don't.

MR. L'ESPERANCE: Have you got a tight belt?

QUESTION: We find that we get slippage even though we keep them tensed fairly well.

MR. SCHROEDER: Well, how do you try to remove the grease from your disks? But I think it would depend on whether you are getting a longer or shorter sheet at your cutoff.

QUESTION: We get a variable sheet. That's the problem.

MR. SCHROEDER: Variable? Well, this depends on how much variation you are getting. Is it more than normal?

QUESTION: We are getting a $^1/_4$-in. variation. We are holding it fairly well, but we change the speed and sometimes change the material, and we get variation of the sheet length, which bothers us.

MR. SCHROEDER: As you know, if your paper is not feeding properly through your double-backer belts—in other words, there is a slippage there—you will get short sheets. If you get long sheets, that's an indication that your drive belt is slipping.

MR. L'ESPERANCE: You might have a worn belt, and it would be a good idea to check the knife itself. There's a possibility you may have a loose belt or a belt that's stretched, or the bearing screw is worn.

MR. DUNCH: I still think he ought to check to see if he has slippage in the double-backer.

MODERATOR SCORDAS: Gentlemen, one thing we can say is that there are no simple answers to these questions. I'm glad that we have three people on either side to chip in and give their knowledge. I think it's terrific. If it was a simple answer, I think we would know the answer to the question ourselves.

MR. DOWD: I'd like to direct a question to the S. & S. representative. How do you set gears on a running register?

MR. FERETIC: In setting gears on a running register I have found in a number of plants that they think they can take out the variation in the printing and slotting by tightening up the adjusting screw, where the chrome-plated dial is. All they are doing is forcing the gears, and in time they will break off. The way to set that adjusting screw is to bring your gears so that they are a perfect ninety and the coupling is pinned, and it's supposed to be backed off a quarter turn when the gears heat up, so that they don't break.

A lot of places they say, "How come those gears are breaking?" and they are Gleason gears, and they shouldn't break. It's the operators that touch those adjusting screws, and they break, because they force them too tight.

That's what I always try to tell people, not to monkey with those adjusting screws when the gears are set, when I install new gears.

MR. DOWD: Thank you.

QUESTION: I just wanted to ask a question of Bill Schroeder Are there many single units in operation which have true rolls running at the same speed as the paper? If so, I wonder what the advantages or disadvantages would be.

MR. SCHROEDER: Well, if this is a Langston machine, it would be an accident. It's not intended to be that way. I can give you the necessary surface speeds, if you want. We usually aim between 93 to 95% of paper speed. Actually, if by any chance they should run slightly over paper speed, this will also work, but we haven't been doing that.

MODERATOR SCORDAS: I'd like to ask this gentleman a question. It might be loaded.

What percentage of the time when you are called out on a service call do you find that it's operational rather than machinery?

MR. GERMAN: I would say at least half the time. We get into a lot of operational kinks on the machines, and the operators are afraid to do anything. They are afraid of the machine itself. A lot of the things can be worked out with just good common sense. You really don't need an expert to come in from out of town and tell you what it's all about.

We do have, of course, like with any other piece of equipment—we still have our problems mechanically, but I would say about half of the time we get into operational trouble.

QUESTION: What do the corrugating manufacturers attribute high and low corrugations to? Is there anything in the equipment that is responsible for it, or is it something else?

MODERATOR SCORDAS: Would you care for an answer from any particular person?

QUESTION: I'd like to hear from all of them.

MR. L'ESPERANCE: That could take all day long. You might have variation in density—that is, paper, caliper—or there is the possibility of insufficient loading of the top corrugator, or you could be overloading. If you overload the top corrugating roller, you are opening up your middle, and you are going to get high and low in the middle, and you won't get high and low in the end. If it's in the reverse, insufficient loading, you will get your high and low in the ends.

It also might be attributed sometimes to what they call S-warp.

MR. DUNCH: Well, heat is a great factor too with highs and lows. Insufficient heat will create trouble, and paper has a great deal to do with it too. The loading of the top roll is also a factor.

MR. SCHROEDER: My answer would be about the same thing. I can't contribute anything more, except to say one thing, that properly designed corrugator rolls will also tend to eliminate highs and lows. I wouldn't say you will get 100% elimination, but it will reduce that.

MR. L'ESPERANCE: I'd like to add to that what I think is another important factor, which is finger-setting. I have been through quite a few plants, and some operators are just lax in their proper setting of fingers. They just set them up there at whatever they feel like.

Well, for an efficient operation with corrugated it's very important that the fingers be set right, and that the adhesive unit be as close as possible.

Take, for instance, starch. When you have a starch operation, I'd like to keep my adhesive unit within twelve to fourteen thousandths. With a silicate operation you have to stay a little further away, say around eighteen to twenty thousandths, providing your adhesive unit is in good shape, your bearings are good, and you have no up and down play or end play on your bearings.

Now, this is all my feeling, but it's based on my practical experience. If I can set my doctor roll between four and six thousandths, I know I can set my adhesive roll between eighteen and twenty thousandths, and then I know I have a very efficient operating unit.

MR. DUNCH: The only other thing is probably the strippers. A good set of strippers as well as your fingers will give you good corrugated board.

MR. SCHROEDER: The only thing I can add to that is that I believe there are two main factors: heat and paper.

QUESTION: At the New Orleans meeting Mr. Phillips, of Longview, presented a paper on a new threading up method, including a change in the rider roll. Has any manufacturing company gone ahead with that machine, or along those lines?

MR. SCHROEDER: Whom did you want to answer that?

QUESTION: Anybody.

MR. L'ESPERANCE: Excuse me, sir. Are you referring to hydraulically loading or pneumatically loading your rider roll?

MR. SCHROEDER: Are you speaking of the type they have on the west coast?

QUESTION: Out on the west coast, yes.

MR. SCHROEDER: Well, we have a new machine now, and you can try it. I don't know how successful it's been. It's too new for us to actually give you any results.

MR. DUNCH: Sir, in answer to that question, although this is bringing certain companies into the picture again—

MODERATOR SCORDAS: Yes. It think we ought to stay away from questions on what one company is doing that another company is not doing. I think we ought to stay away from the sales pitch, if it's perfectly all right.

QUESTION: Well, anybody can answer it.

MR. DUNCH: Well, we have a machine, and we feel there is some possibility of getting that.

QUESTION: You mentioned that high and low is a very important thing, and to try to control the heat and get plenty of heat is the answer. How do you place your side pipes in the roll to get plenty of heat?

MR. SCHROEDER: Why, I don't think it's important exactly where they are located, as long as they reach the bottom.

QUESTION: Well, that's what I'm speaking of. How do you know that, when you can't see how close to the bottom you really are getting?

MR. SCHROEDER: Well, in the first place, each pipe should be tailor-made for this particular roll. And as far as reaching the end, we bend it and make sure that when the part extruding from the outside of the roll is parallel with the roll, and in dead center—they can make sure it is getting to the bottom; so we cut about a $^1/_4$-in. opening, and this will give you a minimum of condensate at the bottom of the roll.

MR. DUNCH: Another good thing to add to that is that it's always good to cut grooves or slots on the blasting pipes to prevent a curlover or a fillin.

QUESTION: Just as a general question, I was wondering whether these two styles or rolls have shown any difference in the high and low, that is, the rolls with the teeth. Has anybody had any experience on that?

MR. SCHROEDER: Well, they haven't been in the field too long, but runnability is about the same as the standard rolls, as far as I know.

QUESTION: If you were buying a corrugator of your own, would you have the corrugating roll chrome-plated? I'd like to hear from everybody but you, Bill.

MR. L'ESPERANCE: Well, as far as chrome-plating corrugating rolls, I'm more or less pro and con on that.

Now, I visit quite a few plants, and a lot of them swear by chrome-plated corrugating rolls, and others say, "I will never have a set of rolls chrome-plated." Although we have had quite satisfactory operation with chrome-plated rolls, where we have them chrome-plated, I know for a fact that where we do have them chrome-plated the chrome has peeled off. If you have an 80-in. machine and you are going to run 78, I'd say go ahead and chrome-plate your rolls. They are going to give you at least 40 to 50% longer life.

Now, what else does it do for you when you chrome-plate rolls? It eliminates a lot of stoning, which you do have to do. Of course, if you are going to drop something in there, or a foreign body falls in, you don't have to worry about that. You can always stone that out with a small wheel, or something like that. So my personal opinion of chrome-plated rolls—I am for them.

MR. DUNCH: Well, chrome-plated rolls are all right. Every company has its own opinion as far as that goes. The only real advantage, I think, of chrome-plating is that if you have an abrasive medium that you are going to corrugate, I think chrome-plating is a very good thing. I wouldn't recommend it for any individual company, I think, unless you are running an abrasive medium, but if you are, I would recommend it.

MR. SCHROEDER: I would agree with both of these gentlemen. If this man who asked the question is a man who chrome-plates rolls, if you could guarantee a smooth coating I would say: Chrome-plate all of them.

MODERATOR SCORDAS: Gentlemen, the man with the most experience—36 years—Denny Shanahan, hasn't been asked a question here lately. How about a question for the slotters?

MR. SHANAHAN: Don't rush them.

QUESTION: I have a question here for Les, or any printer-slotter manufacturer. What can be done to minimize damage when we have to die-cut on the printing cylinder? Don't tell me not to do it, because sometimes you have to. What can you do to reduce this damage?

MODERATOR SCORDAS: Frank, will you rephrase that question again. I think it's—

QUESTION: Well, quite often we will have to die-cut. We can't use a diagonal score, with the boxes running through it, so we will die-cut one of those things. We are beating up the bearing, and we know that, and a lot of other people are doing the same thing.

What can we do to minimize this damage? Or do the manufacturers put out a printer-slotter with extra top shafts?

MR. SHANAHAN: There are no heavy-duty bearings that I know of to take care of that. Of course, when you die-cut on the impression cylinder, you cut it up, and heat-treating that, or case-hardening, will help to overcome that. As far as the bearings, I don't know of any case where you can put in heavy bearings to keep from chewing an impression cylinder up. You can heat-treat that, or case-harden it, which we have done many a time; but as far as heavy bearings put in, we have never done it.

We don't recommend die-cutting on the cylinder.

MR. GERMAN: I'm in agreement with you. We don't recommend die-cutting on cylinders that are made for printing, not die-cutting. You can buy your die-cutting attachments and make various types of cuts, if you want to do that.

MR. FERETIC: I agree with the two gentlemen that it shouldn't be done on a print cylinder, and the attachment which Les mentioned we have, and we put it on the slotter shafts for hand-hold dies, and that's where the hand-holds should be done. The impression always hits in a different spot, and it mars the shaft up something terrible, and they complain about, "How come we are getting crooked boxes?"

I have seen in a lot of plants that the lower print cylinder is all beat up.

QUESTION: With a new set of adhesive rolls and bearings on both a single facer and double backer, what is the amount of runout which we should expect from the adhesive roll, and at what degree of runout should we change rolls and bearings?

MR. SCHROEDER: As you must realize, there is a certain amount of tolerance that's necessary in manufacturing. When we manufacture these rolls to $\pm$ $^1/_{1000}$ each way, that will give you maybe two or two-and-a-half thousandths.

QUESTION: Let's suppose we get a four-point runout.

MR. SCHROEDER: Well, I think that would be determined in your plant, whether it's starting to give you trouble.

QUESTION: Where do you recommend? Three points? Four points?

MR. FERETIC: Well, to my way of thinking, they should be trued up just as soon as they get around four thousandths.

MR. DUNCH: Well, as the gentleman on the left said, the tolerances are very close in manufacturing these rolls, and you have to regrind the rolls then. As for given tolerances, I think the operation itself would indicate whether it was necessary to grind them or replace them.

MR. L'ESPERANCE: Well, I'll go along with these gentlemen, in this respect. If it's four or five thousandths, definitely take those rolls out. I have found that if you can hold the adhesive roll within a thousandth or a thousandth and a half and your stock roll within a thousandth or a thousandth and a half, then you are going to have a very good operation.

QUESTION: Tikie, this may be in the realm of those questions that you don't want. If so, just don't bother to answer it; but on the general subject of printer-slotters I was impressed yesterday with the preventive maintenance program

that Union Bag has, at least in Chicago, and I'm wondering if among the panel there, with the calls that they have and service contacts—whether they feel that there is more of a tendency in the industry now to actually put in practice preventive maintenance, to the extent that Union Bag does, and whether they actually take a press out of service for a day.

Is there a tendency to more of that justifying an extra press?

Moderator Scordas: Well, I think we can phrase that question another way. Why don't we ask the boys on my right on corrugating and the boys on my left on printer-slotter problems about preventive maintenance in general? What do you recommend as far as preventive maintenance? How about training of personnel? Al, why don't you start the ball rolling on that?

Mr. L'Esperance: Well, as far as preventive maintenance is concerned, in the various shops I have been through the cleanliness of the machines is not there. That's a very important factor. I have asked corrugating foremen—I have said: "Your machine is sloppy. It's dirty. You can't even see your adjustments on the machine. How can you make an adjustment on the machine?"

"Well, we haven't had time."

Well, there you have to blame management, because the management will tell you, "Well, there hasn't been sufficient time for it." So there you are, and you are in the middle of it.

Another important factor as far as a corrugator is concerned: with single face I definitely would recommend an additional set of finger holes, and that you always have fingers preset ahead of time before trouble comes along. This way, if you run into trouble, you are ready for it.

Many times customers have complained, "Well, I'm getting glue on my corrugating roller wherever the fingers are." Well, you go in there and you look around, and the glue roll cleaners are worn, and should have been changed long ago. I recommend replacing them every year on starch, and in silica operation I recommend replacing them every eight or nine months.

Mr. Dunch: A good, periodic check, as far as corrugating, and so forth, should be taken up by the maintenance foreman, or any other personnel in the plant. Good maintenance check-ups on bearings and items like that are a great factor in eliminating a lot of downtime on corrugated.

Mr. Schroeder: I believe these boys have covered that quite thoroughly. There's only one thing I would like to add. Usually I find that in a clean plant they usually have pretty good maintenance.

Moderator Scordas: Makes a lot of sense! Denny, how about starting in on maintenance on the printer-slotters?

Mr. Shanahan: Well, I think it's very important to have well trained maintenance men, because a lot of times there's no maintenance work done on a printer-slotter until it breaks down, and many a time we send out service men to take care of a job that should have been done by maintenance men in the plant, and I think a well trained maintenance crew is very important. It can eliminate a lot of service cost.

Question: Could I kind of help answer this question that was asked by Keith?

About a year ago I had to go to the Petroleum Bag Plant, where their maintenance plan was in process, and on the basis of once a week at that time they were actually rebuilding a press, and we were rather impressed with it, to the point that we came back and started a program of our own.

Now every Monday we take one press for maintenance, and we do the same thing with the gluer; we do the same thing with the other machines that are used less frequently on a different periodic basis, and we also try to take one single-facer on Wednesdays, Thursdays, or Fridays, as the case may be. So we have a press on Monday, a gluer on Tuesday, and a single-facer on Wednesday, Thursday, or Friday, and we feel that it has had a very definite pay-off, particularly as far as maintenance is concerned, and we think that it has helped our operation, but we positively schedule them to be down, and it sometimes presents a burden to the plant, without additional equipment, to do this.

Mr. German: I think that one of the best sources of information as to maintenance on a press is being overlooked in a lot of cases, and he's the press operator. Many a time I have talked with the maintenance foreman and I've asked him, "Why didn't you call us a couple of weeks ago? You could have saved yourself a lot of trouble."

"Well, I didn't know anything about it."

But the operator knew the part was wearing, it needed replacing, but they let it break down and they had to order it from the company, which ties you up, and if you can work on a one- or two-week lead, why, you can get your part in and do your changing or fixing, whatever is necessary.

Mr. Ferretic: Another important thing on a printer-slotter is your oil level in the machine. You see, the S. & S. printer-slotter runs in an oil bath, and I have found a lot of places where the oil level is very low for all the gears that are on the operating side, and we have inspection covers on four frames that could be easily removed. They are only $^3/_8$ cap screws, six screws, and they could check the oil level on that ,or even the oil level nipple on that.

I was out just this past week, and the oil level was very low, and that's the way the gears wear, and the slide box, and everything that goes with it. So they say that the equalizer leaks.

Well, all you have to do with that after a while is this. You open and close the feed-in, and maybe you have to tighten that up a little bit. There's nothing for us. They call us over and say that they have an oil leak on the machine. Just by tightening up the packing gland on the equalizer, you can stop that, and I think that's very important on the printer-slotter.

Question: Well, you have all told me how important maintenance is, but I don't know whether anybody besides Conway or Union Bag are tending toward justifying the equipment to actually set up a preventive maintenance program. Perhaps it can't be answered, but I'm still, again, rephrasing the question.

Is there in the mind of the panel a tendency for more plants to actually take equipment out during the week for preventive maintenance, or is it still the old story that when business is good you don't have time, and when is business is no good you can't get the money?

Moderator Scordas: Let me ask my boy over here. He's got the Savannah plant, and several others.

Representative from Union Bag Corp.: Well, the standard procedure was to clean up the press on Saturday and do our maintenance then, because we are running three shifts in Savannah. However, what happens on Saturday is that you can't have 25 maintenance people to go around the plant, so the presses don't get attention, so what we try to do is to utilize the maintenance people on a daily basis and clear off the corrugator so that the maintenance people can work on it.

If we have the right number of presses to handle the work, as I am sure most of you do—maybe you have just the right number of presses, but it varies; sometimes you have a 50% fluctuation between one week and another week during the later part of the season. So certainly you can get the maintenance done during that time.

I'd say it's effective 90% of the time. Actually, however, we're not putting any more time into this thing than they would have on Saturdays anyway, plus the fact that generally the press operator has a chance to make an inspection on his own press each week, and point out what the things are that need attention, so that the next week when he comes in—I'm talking about the little things, not the big things—

the maintenance foreman is there, and he sets up and corrects the thing. So we're not discrediting the idea, but if it can be planned, in the long run we feel it saves money, plus the fact that it keeps the presses in good condition.

QUESTION: What can be done to hold the scores on a press from running off center?

MODERATOR SCORDAS: You mean, on the presses?

QUESTION: The press liners.

MR. GERMAN: I don't know about the Langston presses. I would say in some cases your dull scores will cause this to take place. If your scores aren't sharp, you don't get a good bite into the board, and your sheet can tend to skew as it comes through.

Also, there are some cases where your slots are first. It depends upon the blank size. You will have to watch that, because if you score last, your score runs right where the slot was, and you are liable to be losing control right at that point. You have to make sure that you are still controlling it by your slotter heads.

But I would definitely check on dull scores, for one thing—not gripping it.

MR. SHANAHAN: Well, I agree with Les about the adjustment of your slotter heads. You have to have adjustment of the slotter heads in order to have control over your machine, so that you have control all the time.

MR. FERETIC: What Les said about bad scores I agree with. Also, if the shaft is out of parallel, that would cause your scores to go off the center of your slot. That's about it, I guess.

QUESTION: I'd like to hear from any of the panel as to their views on nitrited corrugating rolls, and why it seems almost impossible for any of our suppliers to furnish us with nitrited rolls, and what they think of them, the pros and cons.

DR. DUNCH: Nitrited rolls? This is bringing up companies again, and personalities, but we do nitrite rolls in certain cases. We have been successful on certain occasions. Let's put it this way, that we nitrite rolls for certain customers.

MODERATOR SCORDAS: Is Mr. Langston here? Is that a loaded question? I don't know whether that's company policy.

COMMENT: I'd like to make a few comments on this nitrited roll situation. It's a little puzzling as to why the machinery manufacturers before the war were evidently able to supply nitrited corrugating rolls that stood up and did a good job, and yet now they don't seem to be able to do so.

I'm certainly not an expert on the subject, and don't pretend to have all the answers, but I think some of them are in these general areas.

Before the war corrugating rolls had somewhat greater side clearances than they do now. They had somewhat larger tip radii on the teeth than they do now.

Now, as you all know, in the nitriting process you get a certain amount of distortion of the metal as the rolls are nitrited. With the more generous side clearances that we had ten years ago, or something like that, you could accommodate these slight distortions and irregularities, which were just in the nature of the nitriting process, but with stiffer corrugating media and higher machine speeds I think all the roll manufacturers have tightened up their side tolerances and nip pressures have increased in order to corrugate these stiffer media. We have to sock the rolls together harder, and we also have the closer side tolerances, which, among other things, improves heat transfer, particularly at higher speed levels.

Under these conditions we just don't have a situation in which we can accommodate the irregularities that are inherent in the nitriting process. The vexing part about the situation is that every once in a while you will get a set of nitrited rolls which will be pretty stable and do a good job, and then that set will develop these irregularities. I think most of the reason is in these general areas: higher speeds, higher nip pressures, closer side clearances.

Now, what do you do about it? Corrugating rolls cost money.

Well, it looks like at this stage of the game, as long as you understand what the risks are and are prepared to accept them, chrome plating is probably the best bet, but every once in a while you are going to get burned on chrome plating too.

There are other solutions besides nitrited 1410 steel and chrome plating that haven't been investigated—heat-treating of the rolls, other materials, and so forth.

QUESTION: I would like to ask the panel as a whole what has been done, or what can be done, to provide scores for triple wallboard at the corrugator, and also for triple hole scores at a press for splitters, as the case may be, number one; and, number two, what do you recommend for running heavy-test board, whether it be a flute A, flute B, or flute C—say, 350 test, for proper scoring at the press.

MR. SCHROEDER: I really have no experience on that. There maybe someone else that does.

MR. GERMAN: I think we are getting somewhat technical on the thing, and possibly our engineering departments can provide more and better information concerning it.

QUESTION: Well, the main purpose of the question was that we're coming into an era where triple wallboard is certainly going to be coming into use, and I think it certainly behooves all of us to give a lot of consideration to it. But your machines are going to have to be equipped to run this material, and when you sell them you are going to have to be able to sell something which is going to be able to do the job.

So we're wondering what thoughts, if any, have been given toward scoring triple wall, because it is one very difficult problem at this point.

MODERATOR SCORDAS: I guess that's an engineering question at this stage, wouldn't you say? I don't think we have had the experience up here on this panel.

MR. GERMAN: I would like to go overboard, maybe, a little on it, and say that two sets of scoring shafts help, by taking a certain amount of your crease on the first and some more on the second. You get away from cracking, possibly.

MODERATOR SCORDAS: Does anybody run triple wallboard? What expereince have they had?

MR. GERMAN: Bill, do you want to add anything?

FROM THE FLOOR: I think I can talk loud enough so that Tike can hear me. Tike, didn't we do in the TAPPI group some testing of different wallboards? Didn't the Engineering Committee run some tests?

MODERATOR SCORDAS: I think Tad Shepherd did that, but he's not here, and I don't know what he came up with.

COMMENT: Tike, I'm afraid I did it. The Institute got about six or seven score profiles, and did make a study. Their conclusions, as I recall them, were that the profile was relatively unimportant. We did find that with different profiles you had to put different clearance settings between your male and female, but, having arrived at, let's say, the closest setting that didn't crack, that they then found very little difference between them.

The big conclusion that they came up with was that you must have moisture in the board when you fold them, and that was the biggest thing that I learned from the study, that if you are having a problem in cracking, then you better somehow get moisture into your board when you fold it—not necessarily when you crease it.

QUESTION: Jack, isn't your question really centered around the problem of crowding on triple wall?

COMMENT: I think to a certain degree that's true. We have run triple wall, but we haven't been able to run it on the presses yet; but we have done what Les suggested, by putting double scores in the centers, and following them through.

However, we have also found that, in doing so, when you fold them directly afterwards, that we have not had a problem

of cracking, or whatever the case may be, but perhaps a day later when you go back to finish these containers, as you may wish, you do run into a very definite cracking problem.

I don't think any of us wish to get into the production of any type of box where you have to whet them down, and so forth. Also, we have even had the problem of their opening while they were in the load, so it's certainly a definite problem.

I didn't mean this to be a technical question. I just wondered what experience anybody had had on the thing, or what they had run into. We recognize there must be water with all of your test board, and I don't know what the other people do. We make a practice of wetting scores on all heavy board at the press, whether it needs it or doesn't.

QUESTION: Tike, I'd like to bring up the subject of chrome-plating rolls again for a minute. I was wondering what the recommendation of the panel would be in regard to the re-chroming of rolls and using them a second time—or a third time, as far as that's concerned.

MR. SCHROEDER: If the rolls are not too badly worn and the customer removes them in time, he can very easily re-chrome, and do a good job. Does that answer it?

QUESTION: You can recommend that as long as the rolls are removed in time from the machine—?

MR. SCHROEDER: That's right, and they can be re-chromed three times, and we have records where they have been re-chromed a fourth time, but the chrome people don't recommend it.

MR. DUNCH: Well, like Bill said, if the rolls are removed in time without too much damage, re-chroming is recommended.

MR. L'ESPERANCE: I'll go along with the other gentlemen on that subject. There are many occasions where I have removed corrugated rolls where they were damaged, and we have been successful in welding them and re-chroming them, andy they have operated for a second time.

MODERATOR SCORDAS: I'd like to add to that, as far as the question is concerned. What tests do you recommend, and how often do you recommend testing?

MR. SCHROEDER: We recommend checking them with copper sulfate about every two weeks.

QUESTION: I was wondering how you detect at what point you should then remove the rolls from the machine.

MR. SCHROEDER: Well, we have found that if the chrome shows a removal about one-third of the way up the flank, we believe they should be rechromed.

MR. L'ESPERANCE: Well, as far as chrome-plating of rolls, the tips of the flute are the areas that absorb the most chrome plating. The valleys do not absorb hardly any chrome plating, and I would say if you run 75 to 80 linear footage, that then it's just about time to make a checkup. I'm sure, based upon my experience, they should last at least that long, before you should have them rechromed.

MODERATOR SCORDAS: Here's a question from West Virginia Pulp and Paper: How hot should liner and medium be to make a good bond? Is there a good instrument available for measuring this heat?

MR. SCHROEDER: There may be someone in the audience who can answer that. I have no experience on this.

MODERATOR SCORDAS: Gentlemen, I'm afraid if you try to measure the temperature of the board with any instrument that we have, you get a friction factor there, and I know of no instrument for that. Does anybody in the audience know of any?

FROM THE FLOOR: You can get thermal sensitive papers which pretty well cover the ranges that you are interested in, and just by inserting these little thermal sensitive papers where you want them, they will tell you what the temperature was. They will change color and become black when they have reached the sensitive temperature.

QUESTION: Where would you get such papers?

FROM THE FLOOR: I don't know. I can't remember. I have some back in my desk.

MR. SCHROEDER: Bert, you are not speaking of temple sticks, are you?

FROM THE FLOOR: No. I'm afraid you would run into the same friction problem. These are little pieces of paper about the size of normal litmus paper; but I can't remember who makes them.

MODERATOR SCORDAS: Gentlemen, at this time why don't we just take a 10-minute break, and then we will reassemble very shortly.

The meeting recessed for about 10 minutes

MR. DOWD: Gentlemen, will you be good enough, please, to take your seats, so we can go through the final windup of the third session.

MODERATOR SCORDAS: I have just been given a question. This is directed to Mr. Shanahan. "We have a printer-slotter that is ten to twelve years old. We are beginning to note register problems. Do you think we are ready for a new gear train?"

MR. SHANAHAN: Not necessarily. Gears have to be worn pretty badly before they affect the register, and there are too many other things that enter into it. Your feed mechanism could be loose, which would cause a variation, and your rubber roller feed-in—if that's worn, it will cause your sheets to run crooked and cause variation. Another very important thing is adjustment of your large shafts. If they are not adjusted properly, they will allow sheets to slip. There are lots of things like that.

We had one four-color machine that the first three colors were registering, and the fourth color wasn't, and the [words not intelligible] . . . locked together, loose on the fourth color, and allowed just the first three colors to work backward and forward.

But there are any number of things, and I think the gear train has to be worn pretty badly before it needs to be replaced. There are a lot of gear trains that get replaced when it isn't necessary.

MR. FERETIC: I agree with what Denny said. It's very important on a running register on the S. & S. that the keeway in the hub isn't worn, where the worm gear is. If you have too much play with worm and worm gear, you develop variation in the slotting, and also your printing.

Like Denny said, your rubber pull roll, if it's out of parallel or worn to a taper, will also cause slippage and improper setting of the springs on the feed roller—we have a size that they are supposed to be set, $3^3/_8$. Some places you go they are pressed so tight that it throws the sheet all over the place.

Also on the feed columns, if the feed rollers are bent and the gears or slotter shafts are out of parallel, it will also cause crooked boxes and variations in slotting.

QUESTION: I have another one here, Tikie. I'd like to ask a question concerning corrugating, and if the gentlemen don't wish to answer it, I see a couple of suppliers in the audience that might be able to help out. But we are interested in prolonging the life of our belting, so I would like to know what you feel about running them a month or two months or three months and then switching, and then continuing to run them out until they are replaced.

Now, I'm referring to a standard belting, not one with nylon or dacron-treated edges. Also, what would you recommend in the line of a sealer on the edges?

MODERATOR SCORDAS: I think that's a legitimate question.

MR. SCHROEDER: If you change the belts or switch them often enough, I think it's perfectly satisfactory, but if you allow them to get thin on the oustide edge before changing, you will run into difficulties.

Now, as far as your coatings on the outside edge, as you may all realize, a belt is used as an absorbent to carry away your moisture. If you coat them, this will prevent this absorp-

tion. Whether you fellows have experienced anything like that, I don't know. I will let the other fellows get in on that.

MR. DUNCH: Like Bill says, changing belts is a good thing provided you change them periodically. If you let them wear down to a thin edge, you run into a problem where you have your bond in the center of your sheet, and if you are running through a double-back, it will not be a very good commercial sheet, say.

MR. L'ESPERANCE: Well, actually, it all depends on the width of paper you are running. If you are running a lot of narrow paper through your double-backer, I definitely advise the rotation of belts, but if you are going to run average —say you have an 80-in. machine and you are going to run, on an average, 76-in. paper, I don't see any need for changing. Let them run as they are, and when they have exhausted their life, then it's time to change belts.

MODERATOR SCORDAS: Would Alan Ward like to say something about belting?

MR. ALAN WARD: Thanks, Tikie. My competitor had hold of the microphone, and he was about to explain in detail.

Once the belts are burned on the outside edges, to put them in the center is just to ask for trouble. The only way it can be overcome is to build up the diameter of the holddown rolls with paper, or something of that sort, so that you get pressure through the belts into the board. Otherwise, you are going to run loose.

I can find differences of opinion in the same plant, where a plant engineer will differ with the superintendent on the reversing of belts, so I hate to start a controversy, but it's been my opinion that belts left in the position they are mounted on the double-backer, give longer service if they are left in that position for their entire life.

I'll give this to Dick Wittig now.

MR. DICK WITTIG: I agree 100% with what Mr. Ward said.

Of course, if you are going to shift your all-cotton corrugated belts, you have to do it periodically. It has to be done the first Saturday of every month, or every six weeks. You can't wait three or four months and then shift them. But if you use a synthetic-edged belt, you can run as is over the life of the belt.

QUESTION: I have a question for the panel. I wonder how long they would recommend running hot plate until cutting it off. In other words, what is the maximum wear on hot plate before you should plane it off?

MR. SCHROEDER: I will answer it this way. We have a machine that's been running for 35 years and never did anything to it. We have some double-backer hot plates running for 35 years. We never did a thing to them; and we have some where we have had to do finishing.

QUESTION: How much warpage did you allow before you recommended remachining?

MR. SCHROEDER: Well, that depends, again, how much variation you people can—well, I don't know just exactly what I mean to say, but how much will you tolerate? If you can afford to have an undercaliper board by four or five thousandths, just leave them the way they are, but if you are getting four or five thousandths' crush in your caliper—

QUESTION: Well, we had no trouble for a good many years, no indication that they were not doing the right job. Is there a program of checking off these hot plates, and how often are they checked? Some of these machines have, probably, 20 hot plates, and some may have only 10. The fellow with 10 really has a problem.

Is there a checkoff list for checking off these hot plates? And how often should you do it?

MR. DUNCH: On hot plates we would like to recommend that you check the plates as often as you check your belts. Pull the belts off the hot plates and check them.

We have found a method of checking them that is rather crude, but it's still effective. Using a knife blade, the straight edge of a knife blade, run it across your hot plates and check the center, and you can tell just how much sag or buckle you have in the plates. However, it should be checked periodically every change of belts, say. If your color starts to show up, you should check them when you have to cut out a piece of the belt, to tighten up the belt.

MR. L'ESPERANCE: From the experience that I have had on the double-backer, if you don't experience any warpage within the first year or two, I can't see any reason why you should have warpage later on, unless there's possibly something in the material—inferior material. But as the gentleman on my left said before, if there is warpage which is due, probably, to inferior material, it would have to be taken out and remachined.

MODERATOR SCORDAS: Gentlemen, there hasn't been any question of warp. Tell me, has warp been eliminated from the corrugated box industry?

QUESTION: This is not a question on warp, but I'd like to ask a question. Many times we wash up our presses roughly by running the ink back up to the fountain. Does the panel recommend that this be done, or is it a practice that is not conducive to good wear on the ground plate?

MR. SHANAHAN: Well, truthfully, I don't know too much about it, but I think a lot of people do it, and I never heard anything against it. I never heard where it does any harm. I don't know too much about that one subject, myself.

MR. GERMAN: You have got to rub that roll, and I'd say in the majority of the plants I have been in that most of the operators set fountain plates too tight anyway, and when you are trying to clean the roll off, it really speeds it up. You are adding to the replacement by doing that.

MR. FERETIC: Well, what Les said is perfectly true. They print their fountain plate up too tight, and that's where they bend and snap off the journals on the ink roller; but we have a washup that's been put out by the Southern Co. that does a fine job on cleaning the osmium rollers and the composition rollers, and there's nothing to it. It's easy to install, and all you have to do is to put the scraper up against the oscillating roller, and it cleans it up in about 2 minutes. The rubber rollers are cleaned, and I would say that's a very good idea, instead of running your ink up into the ink fountain, because they are ruining their chrome-plated ink roller.

QUESTION: We have had trouble with partitions, trying to get a clean slot, using a 21-lb. chip inside and out. Other than moisture, what type of equipment or knives do you recommend to guarantee, or help to guarantee, a clean slot?

MR. SHANAHAN: Well, that question has come up a lot of times, and we have tried different knives. We have tried straight knives, which have done a better job sometimes, but the majority of the time it's in the board, and a lot of the time it's very hard to overcome.

I don't know much more to say, to tell the truth. I know it comes up a lot of times, and we have tried a lot of different knives.

MR. GERMAN: I can't add anything to what Denny said.

QUESTION: Have you tried experimenting with a saw-tooth type knife? It did help to a certain extent, but we still don't get a completely clean slot, and if we are shipping to a manufacturer who uses an automatic partition setter, we get an awful lot of rejects. If it's done by hand, the whole shipment gets accepted.

MR. SHANAHAN: Of course, the main thing is that you don't have an awful lot of clearance between your male and female elements. We have tried a saw-tooth knife too.

QUESTION: What clearance do you recommend?

MR. SHANAHAN: Around one to two thousandths, ordinarily. On some you have to have a little more, but you may get into trouble.

MR. FERETIC: The lower slotting head knives have to be set within a tolerance, like Denny said, between one and two

thousandths, and if they are nicked it will cause a ragged slot, and also with the upper knives, if they are nicked up, you won't get a clean slot like with a new knife.

In the beginning we used to use a straight knife, and now we grind the radius in that knife, and it seems to give you a cleaner slot. It helps a little bit, but you can't really get a perfect slot out of it, as you can do by hand on the foot slot.

Another thing: if you are creasing before you are slotting, you get a cleaner cut. If you are slotting first and then creasing, you don't get as clean a cut as you do when you are creasing before you slot.

QUESTION: On some of the old type corrugators, what is the most accurate way of setting your corrugating roller?

MR. SCHROEDER: You mean, regarding leaning flukes?

QUESTION: No, depth.

MR. SCHROEDER: Fluke depths? Well, we have two means of applying nip pressure, one with spring leveling and the other with hydraulic loading.

Now, as far as the amount of loading on there, this is very hard to tell. This depends on your paper, the rigidity of your sheet, and the roller itself, and this will have to be determined in your plant. There are no fixed rules of just how much pressure is necessary for each particular pair of rolls and this particular type of paper.

MR. L'ESPERANCE: Are you referring to a set of rolls that's been running for a considerable amount of time?

QUESTION: No, it's just an old machine.

MR. L'ESPERANCE: But are you referring to a new set of rolls, recently installed?

QUESTION: Yes.

MR. L'ESPERANCE: Well, the way I set rolls—I sandwich a piece of carbon paper between two sheets of white paper on each side of the machine, and I run that through the corrugating rolls, applying, say, on a particular type of machine—I'd say where we have pneumatic loading, I would say 15 lb.; where we have spring loading—well, I screw that down until I get about $^1/_2$-in. to crusher on each side of the machine, a $^1/_2$-in. spring pressure, and I run my carbon papers through there, and if they match up, if I get top and bottom pressures, the carbon paper will show that on one of the sheets of white paper.

If you definitely get that, and the whites that are showing are identical, then I know the rolls are perfectly aligned. If they are not perfectly aligned, then it's just a matter of moving the eccentric.

On our particular machine, and I believe on a Langston also, it's on the operating side. You move that one way or the other, and mark yourself so that you know just about what you are doing, and you move that and then run another set of carbon papers through the machine, through the corrugating rolls, and see what you later get.

QUESTION: I haven't had trouble with the alignment. It's the depth itself. Can the carbon be used on a cold machine, or does it have to be hot?

MR. L'ESPERANCE: Well, I run the carbon papers on a cold machine, as far as the alignment is concerned. Now, if you are getting any leading corrugation—

QUESTION: I am getting highs and lows.

MR. L'ESPERANCE: Are you overloading the journals, or do you have insufficient loading of the journals?

QUESTION: Well, all we have is a piece of spring steel across the top. That's what I'm trying to find out now: What is the best way to set the depth on corrugating rolls.

MR. L'ESPERANCE: Well, there is only one depth you are going to get out of rolls, and that's what they were cut for. If they were cut 145 deep, you can't expect more than that.

QUESTION: Well, is it best to bring them down until they cut, and then bring them up a little bit?

MR. L'ESPERANCE: Yes. If I can get them to cut on the edges, and then release the pressure on the top roll slightly, then I know that I am at the full depth, and another way to check that, to make sure that you have the full depth, is to caliper your sheet—take the single-face sheet alone and caliper along the length of that sheet. Then you know you have the proper nip pressure.

QUESTION: How much caliper should be lost in running from a plain sheet to printed slots by way of speed rolls?

MR. FERETIC: Not more than four or five thousandths.

MODERATOR SCORDAS: What flute are we talking about?

MR. SCHROEDER: Well, I would say the B flute, or four or five thousandths. A lot of places, if you crush the board too much they reject the order.

MODERATOR SCORDAS: Les, would you care to add to that?

MR. GERMAN: I'd say he's about right on that. I have seen up to 70 spec sheets, but, frankly, I think it's a little too much.

QUESTION: What would you say is the maximum—or, rather, I should say the minimum loss of caliper on A flute that you could hope to get, with sufficient traction so that you wouldn't get slippage?

MR. FERETIC: Well, the way I always instruct an operator is to give the board—A, B, or C, whatever he's running—and to use the sheet for a feeler, so that he has a nice drag on both ends of the roller, not coming out too tight. A lot of times they crush the board, the rollers are touching, and then he changes the speed sometimes, especially if they have a Permaflex speed roller where they have the soft rubber, and they are flattening it out.

They think by coming down tight that their boxes are going to come out straight, but they are making the diameters smaller, and then they are really crushing the board, too. So what I do is get a piece of board and cut it and feel it, and when you get a nice drag on there, you won't have any trouble. Not that you can't push a sheet through by hand.

QUESTION: I'd like to ask the printing gentlemen what they consider the best method of preventing offset at the press.

MR. GERMAN: Excessive speed is one thing that will cause it.

QUESTION: Particularly where you have a full coverage print job with rather heavy print.

MR. GERMAN: When you are running full coverage, I would say you would have to slow your machine down. You have got to bring down an awful lot of ink, and if you start building it up on the rolls, I'm afraid you will start throwing if off, especially from any high-speed operation.

However, as a rule, where we have gotten into heavy dyes and a lot of ink down, the speeds automatically come down with the amount of ink that you have to bring down to do a good job. But the only way I have ever seen it overcome would be to stop the press, clean off the roll, and start the run again, which is time-consuming.

COMMENT: I think the question was offsetting rather than building up, offsetting from your surface of ink to the undersurface of the next box in the back, after they are off the press. Is that right?

QUESTION: Yes.

COMMENT: We have had a little experience trying to eliminate offset. One thing that we have attempted to do, of course, is to install an offset sprayer, which we use.

Another thing is that we try to control the height of our skids. Another factor that's involved in helping eliminate offset, of course, is purchasing the proper type of dyes, and also the type of print that is necessary on any given order.

That's a few of the factors that we use.

QUESTION: Would any difficulty be experienced in going to a thinner finger on one of these old corrugators?

MR. FERETIC: That again depends on your slot width, the original slot width. It wouldn't do any harm. It would just pick up an awful lot of adhesive at the edges.

If you put in a thinner finger, you will have to have a transfer roll, or the applicator—whichever you have on your machine—you will have to have a transfer roll or an applicator to suit.

QUESTION: Wouldn't it help to cut down on the finger thickness?

MR. FERETIC: It definitely could.

MODERATOR SCORDAS: Any further questions?

Well, gentlemen, that concludes the program. I certainly want to thank you for your wonderful participation, and I certainly want to thank the panel. I think they have done a wonderful job. I'm just pleased no end.

I'd like to turn over the meeting now to Dave Dowd.

MR. DOWD: Thank you very much, gentlemen, for bearing with us through the extended days and evening, and we're very grateful this year for an outstanding attendance. We trust and hope that the production merry-go-round at this point leaves us a little more certain on the way home.

Again, this arrangement of panel members is quite unique, and it's been experimental. I'm sure we again are particularly grateful to have had these boys get in front of the group and go through the butterfly stage for the first time, and we're looking forward to seeing you all in Toronto this coming fall, and again back here in New York.

Thanks again, and have a nice trip home!

The session adjourned at four p.m.

Tenth

Corrugated Container

Conference

Royal York Hotel

Toronto, Ont.

Oct. 10–13, 1960

Chemical Pulping Processes

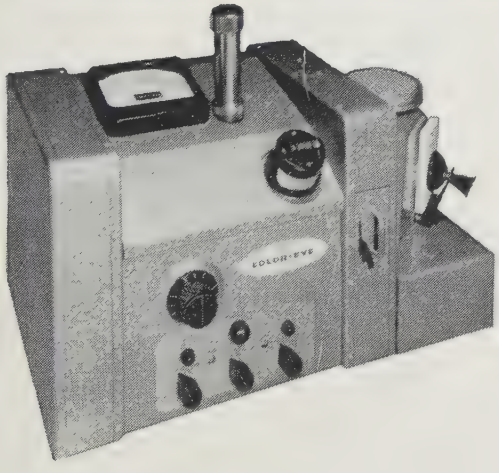
Chemipulp and Chemipulp-KC systems held achieve maximum production of uniform, high quality pulp at lower cost and provide means for efficient recovery of heat and chemicals.

- Hot Acid Systems
- Independent Recovery Systems
- Recovery Towers
- Digester Circulating Systems
- Chip Distributors
- Jet-Type Sulphur Burners
- Spray-Type SO_2 Gas Cooling Systems
- Sulphite Acid Systems
- Neutral Sulphite Semi-Chemical Liquor Plants
- Hydroheaters
- Black Liquor Oxidations Systems for Sulphate Pulp Mills

Chemipulp Process Inc.
Watertown, N. Y.

Associated with
Chemipulp Process Ltd., 253 Ontario St., Kingston, Ont.
•
Pacific Coast Representative
A. H. Lundberg Inc., P.O. Box 186, Mercer Island, Wash.

Color Control with COLOR-EYE®



This unique combination of a colorimeter and abridged spectrophotometer measures color differences directly or against a permanent reference standard. For use in production or laboratory, Color-Eye is completely portable, rugged and stable.

FOR THE PAPER INDUSTRY . . .

COLOR-EYE makes possible simple and rapid determination of "beater room" dye and colorant additions. Color-Eye also provides numerical values for control of pulp brightness, fillers and pigments.

For complete information write for brochure "Color-Eye" Model D.

INSTRUMENT DEVELOPMENT LABORATORIES, INC.
Specialists in Photometric Analysis
67 MECHANIC STREET, ATTLEBORO, MASS., U. S. A.
Subsidiary of ROYAL McBEE CORPORATION

THE PHILADELPHIA CONFERENCE OF THE GRAPHIC ARTS INDUSTRY

March 26, 1960

Delaware Valley

On March 26, 1960, the Delaware Valley Section of TAPPI held its 1960 Philadelphia Conference of the Graphic Arts Industry at the Benjamin Franklin Hotel in Philadelphia, in celebration of the 270th anniversary of the founding of the paper industry in America by William Rittenhouse and the 275th anniversary of the establishment of the first print-shop in the Middle Colonies by William Bradford.

This year's conference was planned to promote better understanding and more effective coordination of effort between printers, ink manufacturers, and paper producers. Cooperating with the Delaware Valley Section in achieving this purpose in the 1960 Philadelphia Conference of the Graphic Arts Industry were the following organizations:

Printing Industries of Philadelphia
Philadelphia Lithographers Association
Philadelphia Litho Club
Philadelphia Club of Printing House Craftsmen
Philadelphia Printing Ink Production Club
Junior Executives Club of the Graphic Arts

The conference program consisted of industrial exhibits, technical papers, panel discussions, and dinner in the Main Ballroom of the Benjamin Franklin Hotel.

Outstanding among the exhibits was a $^3/_8$-scale model of an Isaiah Thomas Press (1700–1800) made by William Linnemans, a high school senior from Red Lion, Pa. While the conference was in progress Mr. Linnemans prepared hand-sheets in a miniature sheet mold and printed them on his press, thus providing unique souvenirs for the more than 300 people attending the conference.

The technical program, which was in progress from 9:00 a.m. to 1:00 p.m., was divided into four main sessions:

Web Offset Printing
Gloss Ink Printing
Paper Surface Characteristics
New Developments in Graphic Arts

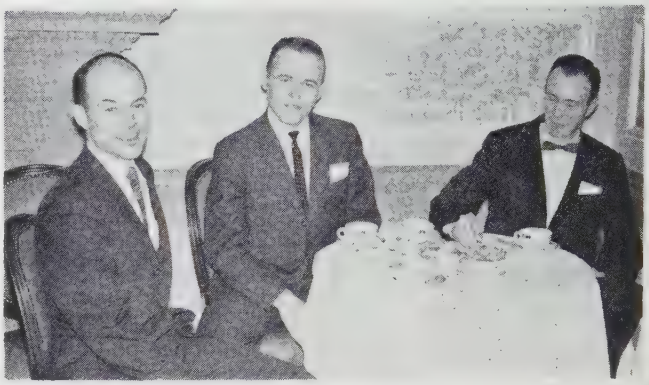
In each session papers were presented by representatives from ink making, printing, and paper producing firms. The texts of all papers are given below.

Dinner was served at 2:00 p.m., following the technical program. Presiding as toastmaster was Dr. Frederick Dannerth, conference chairman, who appropriately introduced each of the following guests:

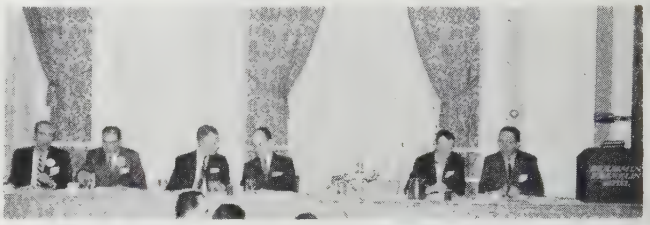
Andrew B. Young, President of the Chamber of Commerce of Greater Philadelphia;
Stan Reinhart, President of the National Association of Photo-Lithographers.
Ray Halik, Offical Delegate from the American Institute of Chemical Engineers;
R. G. Macdonald, Treasurer of TAPPI;
Philip Nethercut, Executive-Secretary of TAPPI;
John Robbins Hart, Rector of The George Washington Memorial Chapel at Valley Forge, Pa.

John Robbins Hart concluded the conference proceedings with an inspiring after-dinner address.

THOMAS P. CZEPIEL, *Secretary*



From left to right: Philip Nethercut, executive-secretary of TAPPI, Thomas Czepiel, secretary, and George Boger, chairman of the Delaware Valley section of TAPPI

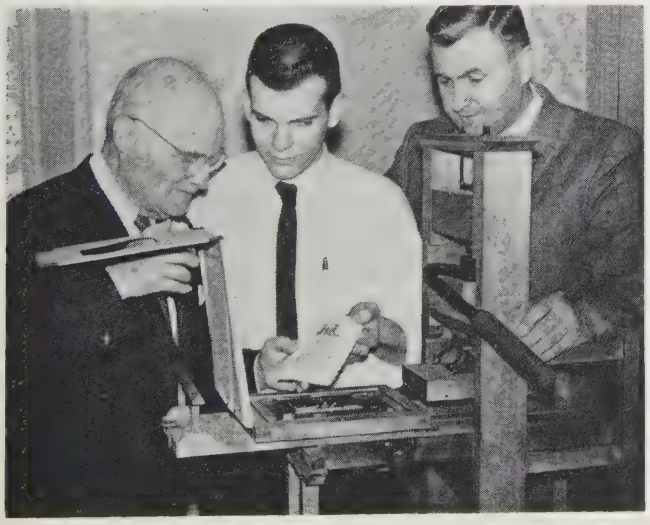


The head table at the banquet: Stan Reinhardt, president, National Association of Photo-Lighographers; Phil Cerasoli, technical chairman; A. Wynn, local section officer; P. E. Nethercut, executive-secretary of TAPPI; G. Boger, local section chairman; Andrew B. Young, president of the Chamber of Commerce of Greater Philadelphia

John Robbins Hart, Rector of The George Washington Memorial Chapel at Valley Forge addresses the luncheon banquet

The head table at the banquet: Frederic Dannerth, general chairman of the conference; Ray Halik, delegate from the American Institute of Chemical Engineers; Al Saindon, vice-chairman of the local section; R. G. Macdonald, Treasurer of National TAPPI; F. Lovegren, P. G. Glatfelter Co.; Henry Smaine, and Thomas Czepiel, treasurer and secretary of the Delaware Valley section; John Robbins Hart, main speaker at the banquet, and Walter Bloomquist, TAPPI Executive Committee

Joseph Abelson, Hamilton Paper Co., speaking on gloss ink printing



Frederic Dannerth, general chairman of the Philadelphia Conference of the Graphic Arts Industry views a handsheet printed on a model Isaiah Thomas press made by 12th grade student William Linnemans under the direction of Ward Yorks

Web Offset Printing

Bernard Green

PRINTING is the medium of ideas, and as quickly as ideas change, print changes. In the past 10 to 15 years, the biggest change in the face of printing has been the change to offset. Although web offset is not included in this big change, I think it will in the near future.

Whole concepts of technique mechanics and materials have been revolutionized overnight till it is now a rare printing buyer who can keep completely informed of every change as quickly as it occurs.

Along with important techniques and quality of sheet fed offset, he must discover the new web offset press. Paper Mills (a great contributor to the progress of printing) announces new "whiter" whites to make blacks crisper, colors more brilliant. New improved double-coated enameled papers give a smoother, better printing surface.

In their own line, the ink makers are no less busy. With LTF they have developed balanced process colors for full color printing, truer standard reds, blues, and yellows. While they improved quick drying inks which promise speedier printing, they developed metalic fluorescent inks for unusual effects.

Hand in hand with all this comes the battle of the processes. Letter press, offset, and gravure wage a constant competition with one another to attract the printing buyers' attention and dollars, and the printing buyer is the one who profits. Out of progress and the battle, he is served with better quality than ever before, final reproduction, and in most cases greater economy.

Far from new, the web offset process has already stacked up a solid record of achievement in general commercial work forms, production, and business publication printing. Where it goes from here will be determined by the press manufacturers, the suppliers, and operators of web offset equipment.

They will determine the position it will hold in the industry in the years ahead. All of us involved in the process have gone and are going through a period of trial and error in determining the demands and the needs of web offset. By no stretch of the imagination are we out of the woods yet. The process is showing such rapid growth and diversification of work that there must be some periods of growing pains ahead. In the last few short years, there has been significant progress.

There are approximately 1000 web offset presses of all types running throughout the country today. Of this number, approximately 750 are printing business forms and items of that nature. Of the balance of 250 approximately two-thirds of those presses are, what you can call, a one-purpose press, printing such things as newspapers, encyclopedias, telephone directories, etc. The balance are doing commercial publication and general printing.

Web offset has two things in its favor to start with as compared to letter press and gravure. Low cost of plates and short make readies give it an advantage pricewise. These, together with smoothness of printing plus availability of cold composition, are the keys to selling the process, but we must add consistently better quality with high production for a low unit cost at all times.

There are many increasing markets for web offset. It is being used in the field of magazine publication, newspapers, encyclopedias, directories, catalogs, mailers, business forms, and many other markets once considered the exclusive property of sheet fed equipment.

The areas where web offset shows the greatest growth is the short run publication field, using lightweight ground wood papers in both coated and uncoated grades. Here it is most often competing with letter press.

The requirements for paper for web offset are more critical

BERNARD GREEN, Majestic Press, Inc., Philadelphia, Pa.

than for letter press. By comparison to papers for letter press, the paper must be free of surface dust, lint, hickies, or loose fibers. The sheet must be as mechanically perfect as possible. The paper must be uniformly wound and free of slack area. Splices must be held to a minimum. The mechanical condition of rolls is also more critical for web offset than web letter press because of the blanket to blanket or blanket to steel situation.

Notwithstanding the above statement, letter press papers are doing a creditable job on most web offset equipment. I know that is the case on our press. Naturally there is an advantage in using offset grade papers, but because of the savings range of one to two cents per pound, we can justify the more frequent stops to wash up the printing units.

I will not go into the technical aspects of paper making for web offset as I am sure those of you involved on that end of the business have heard about and read many articles concerning paper problems related to web offset before.

Everyone realizes that web presses and sheet fed presses with roll feed arrangements are high production machines. But paper people whose experience is limited to sheet fed printing presses and their paper requirements may not fully realize the enormous production possibilities of today's web fed presses. By comparing the production of a popular sized web offset with sheet fed equipment, this realization is strikingly illustrated.

A 35-in., two-unit perfecting web offset press with 22 $^3/_4$-in. cutoff size is roughly equal to a 22 × 34- or 23 × 35-in. sheet fed type press, but since the web press has four-plate cylinders, it is equal to four, single-color sheet fed presses or two 2-color presses as far as the number of cylinders is concerned.

Sheet fed presses run at 4000 to 5000 sheets an hour, while web fed presses process paper three times as fast. This means that the web press equals 8 to 10 single-color presses or 4 to 5 two-color presses of the same sheet size.

At 80% capacity and on ideal situations and products, the production output of the web press is more than 120,000 cutoff sheets in a 7-hour running day. These figures would double on a four-unit press.

I am told that in 1958 the web offset process used 340,000 tons of paper of all grades. I am sure that when the reports are in for 1959, it should show around 500,000 tons.

The ideal situation in any web press operation, whether it be offset, letter press, or gravure, is a one-purpose press. By that I mean running one grade and one type of stock, one size roll using the same colors, the same amount of pages in a signature, etc. Just change the plates, make ready, and continue going. In many cases the web of paper can remain threaded while changes are being made.

Now the question arises: "Where does the cost of web offset fit in comparison to letter press and gravure?" It is my feeling that on publications under a quantity of 250,000, cost must favor web offset. When the quantity goes above that, letter press and gravure come into the picture, unless the job must be printed on the vellum sheet, in which case web offset must be used.

I have been in plants where publications are run in quantities as small as 5000, but these are exceptions to the rule. At Majestic not too much of our work is publication. Most of it is the commercial and mail order catalog variety.

We have found that in our case unless we run a minimum of 25,000 copies, and at least 32-page signatures, sheet fed shows up better costwise. Probably to your surprise, very few of our jobs running on our press have been converted from sheet fed offset. Most of it is coming from what are considered short runs in web gravure and letter press, sheet fed rotary letter press, and other markets already using web offset. It is our opinion that there is not enough of a sales market in the Philadelphia-Delaware Valley area, exclusive of publications, to keep our press going continuously. For this reason, we have opened up a New York sales office.

Some plus features in addition to those previously mentioned are:

1. With the development of bright type, offset negatives are easily made from letter press plates.
2. Cost of paper is cheaper in rolls.
3. Flexibility in use of almost any kind and weight of paper.
4. Fast makeready saves radically on time costs and gives this process remarkable flexibility on emergency jobs.
5. Immediate drying.
6. Speed.
7. Fold while running.

Some of the questionable features of web offset are:

1. Cost of a 35- to 38-in., two- to four-unit press with drier is about $250,000. You can expect to spend $25,000 to $50,000 in waste of labor, materials, etc., before you are satisfied with quality and performance.
2. Additional capital to use for operations—money is needed for storing large quantities of paper, additional labor, related equipment, etc. I would say 33% in additional funds is needed beyond the cost of equipment.
3. You can hurt yourself tremendously by delivering inferior jobs at the beginning. A first impression can be a long and lasting one.
4. Space. Besides the area taken up by the press itself, you should have plenty of room for storing roll stock. Stock should be bought in carload quantities for economy and availability. Most paper mills will not sell special items in rolls in less than carload lots.
5. High production on press necessitates equally high production on finishing equipment. Money will be needed for expensive finishing machinery.
6. Constant cutoff. Even though the width of the roll may be varied, cutoff cannot. Because some jobs do not utilize the entire cutoff, the waste can overcome the advantage of speed. I hope the time will come when manufacturers can build presses with variable cutoffs; then the web process will have it "made."
7. Paper waste can be a substantial disadvantage and, depending on length of run and other factors, can more than counterbalance the advantages of web offset. Spoilage can run from 7 to 30%, depending on how many colors, size of run, quality required, and mechanical help. Any paper left on the core less than 6-in. thick is also waste.
8. The plate life is more uncertain than in letter press and gravure; hence, more replating is required though the process is speedy and the cost comparatively low.
9. On unusual long-run jobs (in the millions), offset does not compete with either of the other major processes on speed and price.
10. In many cases cheaper grades of paper can be run on letter press than on offset.
11. Patience and fortitude. Though I mention this last, it is really of paramount importance. The first year or so of a web operation can bring on more misery than anything I can think of. There are so many problems to overcome, which come slowly under normal conditions.
12. A one-shift operation cannot show profits in web offset. A web press standing still is a useless and expensive piece of machinery. But running continuously and smoothly, it's a beautiful and useful machine; and this is the key to the operation of a web offset press: keep it running.

Now let's look at the future. Certainly anything can happen, but on form and precedent I believe that most of us would be inclined to wager on the slow but continued growth and advance of web offset. A choice of conversion methods is available today depending on the technical aspects of the job, the kind of copy, and the quality results desired. Jobs can quickly and easily be converted to offset. Whether this makes sense or not right now is a matter of sharpening your pencils and consulting with your banker. This important

point here, I believe, is that each conversion method has something to offer, and ingenuity on the part of production men can turn up some interesting uses of existing techniques or even modifications to fit a particular situation. It is certainly clear that this moment web offset is not stymied while awaiting more developments in cold composition or photographic typesetting. Cold composition is bound to make progress, and as it does, this will tend to emphasize the advantages of web offset.

A Papermaker Takes a Look at the Web-fed Offset Press

M. M. Muntz

I WOULD like to begin my 10-minute sting, with a description of the web-fed offset press. This is purely a nontechnical description, but was my first impression. The web-fed offset press is divided into three sections: the unwind stand or flying splicer, the printing unit and the folding unit, with each one unit being connected to the other. The splicer is the contest arena where a game originates to see if the last inch of paper can be salvaged off of the core and if the connection is not missed while the innocent paper mill representative is still sweating, the game goes into overtime to see which core contains the strongest paper when actual contact is made.

In the printing area, the sheet is simultaneously wetted with water, squeezed, and passed through a drying oven at a high temperature. Being unsuccessful in either smashing or burning the sheet, a choice exists to either pull the sheet apart or tear it in passing from the printing unit to the folding unit. Between these two units, the paper is stretched to the point, if hit or tapped gently with a pencil, it makes a good substitute for a bongo drum.

The folding unit consists of a mass of turning bars, similar to, but far more complicated than an exercise jungle on a children's playground. Here the paper is stretched, twisted, turned, perforated, and folded into signatures. While the description may seem slightly foolish or exaggerated, it points up to one fact: Basically, what more torture could be applied to a ribbon of paper and expect a good production rate and a top quality printing result.

Costly web-fed offset units are being installed or have been installed by various printing houses for one reason—production. This means long runs at top speeds with minimum or no down time, producing a quality printing job. Without long runs, this unit is not economical, without speed and little down time, excessive costs are obtained, and as important as the first three items, quality printing is needed to obtain business. This all adds up to one thing—the paper itself.

We manufacture three types of paper which is printed by the web-fed presses, namely a bulking book sheet, a two-side pigmented sheet having less than 5-lb. of coating per side and register bond grades for the forms industry. I would like to cover briefly what we believe are important paper properties in order to successfully operate the web-fed unit.

1. *Tensile.* In both the machine and cross-machine direction, tensile is the major physical property needed for the sheet to be pulled through the press. This strength property is becoming more and more necessary since the paper customer calls for lighter weight paper with a high opacity value.

Mullen was not found to correlate with press operations or with the tensile value of the paper. True, tensile and Mullen correlate, but in a sheet of high ash content, the two properties are irregular in their relationship to one another.

M. M. MUNTZ, P. H. Glatfelder Co., Spring Grove, Pa.

2. *Surface Characteristics Necessary for Good Press Operations.* The surface must have a uniform ink-receptive surface, since there are practically no recesses in the rubber blanket of the offset press as occurs between the letters and halftone dots on the letterpress plates, the ink must enter the capillaries of the paper or be squashed out with a resulting fillin of type and halftone dots, impairing the appearance of the impression. The surface must be clean, free from dust, lint, and fuzz and must be extremely well bonded in order not to pick. The reason for this is simply economical and quality wise, the less foreign material or free dust, the less down time for washups and better reproduction of print matter. Nobody appreciates "hickies" or spotted areas on solid printing. A dirt-free surface, also reduces the waste of printed signatures, especially since frequent shutdowns cause a loss of printing quality due to upsetting the equilibrium between ink and water. It is worthy at this point to mention the fact that the Dennison wax pick test need not be as high as that required for a sheet-fed offset operation.

3. *The Paper Must Be Free From Holes.* Holes not only ruin a signature or result in complaints, but also can cause the sheet to break down in the press due to the tension applied to the paper. It is interesting to see a break occur at the press section or before the folder and watch the sheet catch fire in the drier only when it is a competitor's sheet.

4. *Dimensional Stability.* The sheet must be dimensionally stable and have as little contraction and expansion as possible. However, the moisture content of the paper for web-fed operations is not as critical as required by sheet-fed operations and can be quite a bit below the usual 6% figure ranging as low as 3.5% moisture content.

5. *Good Rolls and Splices.* These are critical items necessary for good press operations. High speeds demand maximum diameter rolls with a minimum number of splices, per roll. As the diameter of the roll increases, the variations of basis weight and caliper are magnified and shows up as soft spots in the roll or soft ends, wrinkles or "baggy" ends on the press. These are definitely not assets to good press operations. As a result, uniform basis weight and caliper are essential physical paper properties, not only for good rolls, but also for a uniform printing surface.

Splices must be a thin, heat-resistant type splice. They must be straight with no "dog-ears," and have as short lap over as possible. One particular customer of ours limits us a specific number of mill caused web-breaks per 100 rolls or approximately for 260,000 lb. of paper. Therefore, breaks due either to bad splices, defective paper or rolls become expensive for both the paper manufacturer, who pays for the down time and the wasted signatures, and for the printer, who loses his carefully planned production schedule.

Another important property involving rolls, basis weight, and caliper is the yardage factor. If the customer pays for the weight and specific diameter, he assumes that a definite quantity of paper or a definite number of signatures will be obtained after a deduction of regular waste percentage. Yardage is the basis for these measurements. One point not to be overlooked is the aid a printer can extend to the paper manufacturer by:

(a) Keeping adequate and detailed reports of lost time, breaks, and waste and making them available for study. Whenever possible, tails of press breaks and splices should be saved for possible solutions as to what caused the break.

(b) If new paper is being printed, the ink manufacturer should be consulted for the ink formulation. Inks should be designed for the speed and size of the press as for the type of paper being printed.

In summary, the paper requirements necessary for successful results for web-fed offset operations are:

1. Tensile strength.
2. Uniformity and cleanliness of the paper surface.
3. Uniform basis weight and caliper.
4. Good rolls and splices.

Web Offset Inks

Ludwig P. Horn

In a recent issue of a national trade magazine, there was an article describing the pros and cons of web offset. On the pro side were two items which caught my eye—cheaper paper and cheaper inks. On the following list of cons were noted—more paper waste, and more trouble with inks. I would like to dispute this last item.

It seems to me that the only drawback in inks for this process is the lack of knowledge or information available to the trade. In reviewing web offset inks, let me start by saying that they *are* different, they are in my opinion *less* complicated and *less* troublesome than normal offset inks. Having made myself wide open to argument, I will try to give my side of the story.

Lets review a modern offset ink for sheet-fed presses of the quick-setting type which dominates the market today. It is a very complex, delicate concoction. Its main component vehicle is made by balancing a very soluble resin with a very hard, almost insoluble resin in a varnish cook in linseed oil. When the varnish reaches solution, about 25% of a solvent is added. When making the ink, this varnish is almost always modified with other varnishes to obtain various properties. On the average coated paper it will set in about 5 minutes and dry hard enough to go through folding, cutting, etc., in about 2 hours. Although there are inks which set in less than one minute and are hard in about 15 minutes, they are very expensive and cause much trouble on the press—notably misting or flying. These inks obtain their set by releasing solvent into the paper. The less capillary action the paper has, the slower they set. After the solvents and soft oils are drained into the paper, the balance of the ink takes up oxygen and dries. Without joining into the debate on just *how* an ink dries, suffice it here to say that there *are* chemical reactions which take place to change the liquid and plastic portions of the ink into solids. This takes time, often as long as 8 hours. On occasions it takes days. Sometimes they never do dry!

Now lets look at web inks. Inks for web offset fall into two large groups: those that are dried by heat, and those that are not. The inks which are not heat dried can depend only on penetration into the paper to set up enough to be handled immediately after being printed. Whether the whole vehicle penetrates the paper as on typical letterpress news inks, or if part of the vehicle, such as solvent is diffused into the paper leaving solid resin and color on the surface, the point remains the same as far as drying method is concerned. These inks are very seldom used at speeds exceeding 500 f.p.m. In order to accomplish faster web speeds, heat drying inks were developed. It is this type of ink with which I shall concern the rest of my talk. You might think of most heat-set inks compared to normal inks as being lacquers compared to enamels. They dry by the loss of solvent. There is no chemical reaction needed.

How are web inks made? Unlike regular inks which depend so much on vegetable oils, they will contain only traces if any. The backbone of heat set ink is a varnish made of very hard but soluble resin which is dissolved in a solvent. To oversimplify the case, the ink when printed on the sheet starts to release the solvent into the paper. Before this proceeds very far, the web travels into the oven where the temperature rapidly jumps to about 450°F. The solvent left in the ink is rapidly evaporated, leaving the resin and pigment on the sheet. Web speeds of 800 f.p.m. are fairly common. In an 8-ft. oven this means the ink must be dry in 0.6 second! At 1300 f.p.m. this time is only 0.4 second! Any student of organic chemistry will agree that no chemical reaction can be depended on to take place in that time. Before I forget about it, there is another type of heat-set ink. This type uses a very heavy mineral oil and/or low melting-point resin in conjunction with the solvent. When this ink hits the heat, the oil and resins become liquid enough to penetrate the paper while the solvent is evaporated. Obviously this leaves very little binder on the surface to hold the pigments and is suitable for only the cheapest work.

I have mentioned the word solvent a few times, so I'd better go over this subject briefly. The solvents used in offset inks are narrow boiling range fractions of kerosene. Whereas kerosene starts boiling at 350°F. and has an end point of 580°F., the two most common solvents used for these inks have boiling ranges of 470 to 520°F., and 500 to 560°F. This means they will evaporate rather slowly at room temperature, but will be boiled out of the ink film in the oven. Where kerosene has a KB value of 96, these solvents have a KB value of 26. This means they are not very strong as solvents go, and do not swell a hard blanket. Also, the lower the KB value the more easily they are released by the resins.

When it comes to making adjustments on the press, the best thing a pressman can do is to throw away his old favorite dopes and curealls. One of my reasons for saying these inks are less troublesome than regular offset inks is the fact that they are nearly always made for a particular set of conditions.

The most common problem seems to be drying trouble. Too often, the paper will not take the normal amount of heat without wrinkling or blistering. The heat is lowered, and presto! The ink is not drying! When this happens, it is of no value at all to put conventional driers into the ink. In fact, since most driers are rather acid in nature, they can slow the release of the solvent by the resin. By adding a fast solvent instead, you are applying less resin to the sheet and there is less to retain the solvent. If inks from the first unit on multicolor presses begin to pile on subsequent units, they are drying too fast, not too slow. Some slow solvent is a big help here.

Offset pressmen the world over have a favorite binding or water resistant varnish. Your inkmaker can supply some heat-set varnish for you to use in their place. Since this varnish is water resistant by nature and a very good binder when dried by heat, there is no sense in using something which could ruin your drying speed. A problem which is unique to this process in its severity is the build up of paper dirt on the blankets. The only things you can do to help this situation are to make the ink as soft and as long as possible and still run without greasing. This will flush the dirt from the image area and carry it right through the press. When running a light form, the dirt may be carried back into the ink system because not enough fresh ink is coming down from the fountain. Putting a minimum of ink in the fountain, throwing it out when it gets dirty and adding fresh ink can save more money in washups than the cost of the ink.

When greasing is encountered, chances are the ink is too soft or is breaking down on a hot press. Some heavy varnish and some dry magnesia will usually clear it up.

Trapping is the same problem here as on sheet-fed presses, perhaps a little more critical due to the high speed. The same rules for having each succeeding color softer than the one it is to cover hold true. An inkometer reading of about 1.2 difference is usually sufficient.

The higher the speed goes, the more flying or misting becomes a problem for the inkmaker. Inks are usually tested for this before the printer gets them. If you have an ink which is flying, if you can soften it with solvent, do so. If you need further help, call your inkmaker. While waxes and gel compounds can help, they are just as likely to cause slow drying.

To sum up, remember that web inks are very soft, fast drying relatives of older inks. They contain lots of solvent. Don't expect the inkmaker to give you an ink which will stay open on the rollers for several hours on a hot press and then dry in half a second in a short oven. While this is the

Ludwig P. Horn, Crescent Ink & Color Co., Philadelphia, Pa.

way we are proceeding, there is a limit at present. Don't expect us to make a strong, dense, fast drying color for peanuts. We can make very cheap resins work very well for letterpress, but the problems of lithography make it unlikely these inks will get cheaper. Instead, as speed goes even higher, so will the research and material cost of inks.

Gloss Inks

John Moody

I HAVE been asked to give a short talk on gloss inks and their problems from the standpoint of the printer. To keep me from becoming too biased and to make me hew to the line, my two colleagues will discuss the same subject only from the viewpoint of the inkmaker and the papermaker.

In our plant the quest for something to improve the appearance of the printed page dates back many years. Advertisers and editors alike were clamoring for something which would give more eye appeal to their pages and gloss ink at that time seemed to be a step in the right direction. Since that time there has been a steady increase in the volume of gloss ink used which certainly justifies our early assumptions that gloss ink, while not a panacea for all our troubles, has certainly proved to be a remedy for some of our ills.

We were fortunate at that time in obtaining the services of E. P. Ryan, whose background included experience on gloss inks in label printing. As our chief chemist, Mr. Ryan headed our newly formed Division known as Materials Control and he guided us through some of our most trying times with gloss inks.

As you all know gloss inks are basically standard inks with resins and varnish added to impart the gloss or finish which gives luster and appeal to the printed page.

Our early attempts at running gloss inks produced the usual myriad of problems and variety of headaches that all new ventures seem to hold for the novice. We learned through trial and error how to solve some of our problems and thought we learned the solution to others, however, from time to time some of these problems still come back to haunt us.

Now just what were in many instances (and by the way some still are) our problems with gloss inks?

1. Inability to get satisfactory results in super paper.
2. Penetration or ink striking through the sheet.
3. Offset in pile dried sheets.
4. Retarded drying with heat set inks.
5. Poor trapping.
6. Pattern.
7. Intaglio printing.
8. Additional vapors on gloss heat set inks.

I have listed here our major problems in the handling of gloss inks from the printer's viewpoint. You will also note that I have mentioned regular oil inks and heat set inks.

I have mentioned this because we are presently engaged in running gloss inks on sheet fed presses where the sheets are pile dried, web presses which deliver sheets are pile dried, and high-speed web letterpress and offset where the web is printed on both sides dried, slit, folded, and delivered in one continuous operation. Each produces its own set of problems with which you must cope at all times.

As a matter of fact, in the beginning our problems in the aggregate were such that we were pretty much like the little boy who dropped his bubble gum in the chicken house and began to look for it, we were confused.

But enough of that, let's now take a look at each of the aforementioned problems and see what we have done to alleviate or correct the conditions.

Inability to Get Satisfactory Results on Super Paper. This is one of the problems to which we have found no solution. Gloss ink just does not lend itself to smooth printing on super paper. However, we have not abandoned hope and are still working on the problem. In the meantime we have gone to coated paper to secure the smoothness so essential in getting the ultimate from gloss inks.

Ink Penetration or Ink Striking Through the Sheet. This condition we find most prevalent in our pile dried sheets. When this problem exists, we often find it necessary to make a paper change. On the other hand we may find it necessary to pull short trucks, i.e., trucks containing only a fraction of the sheets normally allowed to go on a truck.

Offset in Pile Dried Sheets. When gloss inks are used in conjunction with coated paper, the ink tends to set up on top of the sheet and drying is not aided to any extent by absorption. In our plant a paraffin wax spray is used to prevent the sheets from sticking together, therefore, we find it necessary to use a larger gear on the wax machine when gloss ink is used to insure a better wax coverage. Here again we find it profitable to pull short trucks and wind the stack after it has set for a few hours.

Retarded Drying with Heat Set Inks. When using gloss inks you always run the danger of carrying more gloss inks than you would normally carry if the inks were regular. The additional resins and varnish in the gloss ink tends to slightly weaken the ink and to secure depth of color, we are prone to carry just a fraction more ink. When this happens, you are into drying trouble. The only remedy is to increase the heat and if this does not solve the problem, slow down the press.

Poor Trapping. Off hand you would say this is a problem for the inkmaker but this may not always be the case. For instance you may be attempting to match a proof which has been pulled dry, or the proof may have been pulled on a slow moving proof press or under entirely different operating conditions from which you operate. There are other variables such as speed, temperature control, humidity control, paper variations, roller hardness and setting, and any one or all may adversely affect trapping.

Pattern. This can be caused by or be the result of several different things or conditions. Some of the most common causes are screen angles, incorrect impression, too great a volume of inks, poor register, and ink which has been doctored on the makeready or during the press run.

In most instances the experienced pressman or pressroom foreman can detect these irregularities and make the necessary compensation to correct the condition.

Intaglio printing. This may also be the result of ink which is not working properly but in our experience we have found incorrect impression to be the greatest offender.

Additional Vapors on Gloss Heat Set Ink. Again we must face up to the fact that we are forced to carry just a little more ink to get the desired results. Coupled with this is the fact you are running coated paper which does not aid drying by absorption and the ink sets up on top of the sheet. When this condition exists, more of the vapors must be driven off in the drying process, hence more condensation takes place on the cooling drums and the additional troubles accrued therefrom.

Now to summarize, let me say that for the pressman who would get the best results with the least amount of trouble when running gloss inks would be wise to do several things.

1. If at all possible, he should consult with his foreman in the selection of the stock to be used, taking into consideration the type of equipment on which the job will be run and the nature of the form.

2. He should exercise extreme care in making the job ready, paying particular attention to the impression, keeping it preferably on the light side.

3. The ink must not be forced into the paper, but deposited on the surface in a smooth, even film.

4. The stock must not be too absorbent in order to avoid vehicle drainage.

5. The press and ink should not be too cold, otherwise picking, lifting, and register trouble will result. It is here that many a job has been ruined by the pressman doctoring

JOHN MOODY, Curtis Publishing Co., Philadelphia, Pa.

the ink. As a matter of fact it is common practice, particularly in the winter time, to place the cans or buckets of ink in a warm room in order to facilitate the flow of ink when it is put in the press.

6. Thorough makeready eliminates the need for overinking, heavy impression, and their resulting troubles and it will also help to reduce offset in pile dried sheets.

7. Finally, judging of the printing results should be reserved until the press is in full operation, to avoid tampering with the inks or the makeready.

Gentlemen, the tools of the trade are many and the skill with which we handle them can enhance our reputation as printers and stamp us as skilled craftsmen. That to me is sufficient reward for our labor.

Gloss Ink Printing

Dan O'Connor

It is a distinct honor and privilege for me to be here this morning to participate in this panel discussion on gloss inks and I would like to take this opportunity to thank the committee for their kind invitation.

In formulating gloss inks the inkmaker must, of necessity, have certain facts clarified. Some of these essential facts would be:

1. The type of press to be used.
2. A sample of the stock to be printed.
3. The nature of the overall size and coverage of the particular form and pertinent information regarding the number of colors to be applied. The color progression and definite information as to whether the job will be run wet on a multicolor press or printed single color by means of several trips through the press. Last, but far from least, information regarding any subsequent varnishing or imprinting that may have to be applied at a later date. This latter is quite important as it will have a definite bearing on the formulating procedure.
4. The size of the loads expected to be handled at the delivery and the type of offset spray that will be used.
5. Any other pertinent information regarding permanence, abrasion resistance, bleed resistance, etc.

There is absolutely no question regarding the fact that the more information the inkmaker receives regarding a job, the better he can formulate his ink.

Since many of you here are not inkmakers, I think that one of the best methods of clarifying the subject of gloss inks would be to disect an ink into its various components and discuss them in more detail. This might give you an insight into the inkmaker's mind as he faces the problem of formulating a finished gloss ink. To a degree this reminds me of the teen age hot rod, who buys a jalopy, tears it completely apart and proceeds to put it back together again. Unlike our young friend, who usually ends up with a few extra pieces and a model that the original manufacturer would never recognize, we hope that you end up with a much clearer picture of a gloss ink.

Fundamentally a gloss ink is composed of pigments, varnishes, reducers, compounds, driers, and on occasion other additives for special purposes. These are the basic building blocks used by the inkmaker to produce gloss inks.

Pigments obviously are required to achieve the desired color but they also serve the secondary purpose of aiding in the lay, or leveling, or smoothness of the final printed film. Because of the variation in their chemical properties, they will yield quite a gamut of physical properties when formulated into gloss inks. For example, the opaque pigments are quite flat, have very low oil absorption and usually must be carried in quite high concentrations to achieve the desired color and body in the ink. The net result is that only a limited amount of the gloss producing vehicle can be incorporated and it is quite difficult to obtain finish. Many an ink chemist has developed gray hair and a fair case of ulcers trying to produce a gloss ink match for the lovely, pastel, water-color sketches that originate in the gray flanneled, ivory towers of Fifth Avenue. Sometimes they cannot achieve an acceptable match without the opaque pigments, but I can assure you they will certainly do all in their power to formulate their gloss inks from the transparent pigments. The latter usually have much better finish and because of their higher oil absorption and greater strength can be used at comparatively low concentrations. This then means that a much higher concentration of gloss producing vehicle can be used. There is no denying the fact that the degree of gloss will vary directly with the thickness of the ink film that can be printed on the stock, hence the formulator will purposely keep the strength of his ink to a minimum, consistent with nonoffsetting on the given stock. It is at this point that I think you can see the reasoning behind the ink maker's request for a sample of the stock to be printed. He is deliberately skating on thin ice with a weak, low pigmented ink that will be carried as full as possible in order to obtain the maximum finish. Here we have all the necessary ingredients for trouble. I am sure that many of you have taken an ink that worked very well on one given stock and printed it on several other different types of stock with disastrous results. You probably have noted an appreciable change of shade from stock to stock and also varying degrees of mottle and offset. It is at this point that the inkmaker would start to tailor-make his gloss ink for the given stock. This obviously should be discussed in the category of pigments because he would now vary his pigment combination and concentration to end up with an ink that would match for color, print without mottle, bind well, dry satisfactorily, and not offset in the pile.

Generally speaking the smaller the particle size of the pigment the greater the oil absorption and the more the finish. This is quite important in gloss inks because so often, as with the pastel shades, the amount of color pigment required is quite limited and a substantial quantity of the transparent white extender must be carried to achieve desired printability. Quite naturally the formulation will use the extender that will produce the best finish.

Before we leave the subject of pigmentation, I would like to mention some of the approaches the ink man will use to improve the finish of a given formulation. For example, more finish will be developed if the ink is ground on the mill at a maximum pigment concentration in a minimum of the vehicle, with the balance of the vehicle being added after the grinding operation. The explanation of why this is more effective in producing finish is an interesting point. The heavier the viscosity of the pigment paste during the grinding operation the more effective the mill operates to deagglomerate the pigment and more intimately physically admix the varnish and pigment. This theory is actually carried to the extreme in other coating fields, as well as in some segments of the ink field, where solid "chip" dispersions are made on very heavy duty dispersion equipment. These chips are then reduced with solvents to form the finished coating or ink.

Before we deviate from the pigment discussion, we should mention the use of flushed colors. The latter most always yield *greater strength* and *increased finish* over the so-called dry grind approach. However, not all pigments lend themselves to a flushing operation.

In our analysis of gloss ink components, the most important is that of varnishes. It is in this area that the ink formulator must diversify in accordance with the type of press and the method of printing. For example a gloss varnish that might work beautifully in a letterpress gloss ink, might not work at all well in an offset gloss ink and most certainly would cause considerable trouble in a heatset gloss ink. Since most gloss inks are run on letterpress or offset presses that do not employ heat we will discuss them in more detail. These gloss varnishes are composed of resins, drying oils, and sol-

Dan O'Connor, American Litho Varnish Co., Kearny, N. J.

vents. The resins normally used are the insoluble, high melting point phenol-formaldehyde, or maleic-modified resins. These are solubilized by heating to an elevated temperature in an oxidizing oil, such as linseed, oiticica, fish or chinawood oil, until solubility is achieved and then cutting back with an aliphatic solvent. The ideal gloss varnish is one that possesses the maximum in *"Hold-Out"* after it is applied to the stock. The term *"Hold-Out"* may be defined as that physical property of a varnish or ink that permits the solids of pigment, resin and some oil to remain *at* or *on the top surface* of the stock while the balance of the ink vehicle system quickly penetrates.

One of the prevalent theories that best explains this physical phenomena in a gloss ink may be explained as follows. The resins used are normally only marginally soluble in oils and insoluble in aliphatic solvents. By heating the resin and oil together at higher temperatures this solubility is improved to the point where the mixture will tolerate some reduction with solvent. Thus we are able to obtain the lower viscosity in the vehicle system that is required for proper distribution on the inking systems of the press thus allowing the ink to be carried to and printed on the stock. Immediately after the ink is printed the solvent and some of the more limpid oil penetrates quite rapidly leaving a much higher viscosity combination of pigment, resins, and oil on the top surface for maximum gloss. I have a personal theory on gloss varnishes and other varnishes similar to them that is almost as perplexing as the old story of determining which came first, the chicken or the egg, and I shall try to clarify it. The normal concept of a gloss varnish is to believe that the solid resin is a solution in the oil and solvent, yet further additions of oils and solvents quite often kick the resin out of solution as evidenced by a distinct cloud. However, if we think of the varnish as a solution of oil and solvent *in the resin*, the behavior of the ink on the stock and the cloudiness on further dilution are more readily understood. In other words the solid resin just does not like the oil and solvent and takes full advantage of the porous nature of the printed surface to eliminate them. Perhaps the best example to illustrate this theory is that of the overprint varnish, which although unpigmented does tend in most cases to print and lay very well on most stocks.

In regard to oils, linseed is the most commonly used, but the harder faster drying oiticica and chinawood will frequently be used where the ultimate in scuff resistance is desired. Fish oil is used primarily in those cases where economy is required and where the slight residual odor is not objectionable.

For heatset gloss inks great care must be taken that the ink will dry sufficiently fast and that any residual stick will not remain in the film. To this extent caution must be exercised in the use of any oil in a heatset gloss varnish. In the publication field as little as 1 or 2% of oil in the ink may cause a rapid ink build-up on the second side top-sheet. However, there are many intermediate applications, such as in coffee bag gloss inks, where a fair amount of oil can be and is used to achieve the desired gloss and binding.

The category of reducers is not too complicated and as the name would imply these materials are used to reduce the tack of the ink to a safe level for proper distribution on the press and printing on the stock. The materials most commonly used are aliphatic solvents and low viscosity drying oils. On occasion when the use of the above materials results in an ink with too much flow, hence mottled printing, the formulation will use other pastelike, low tack materials to not only reduce tack but control flow. Examples of these latter materials would be such items as lanolin, cup grease, petrolatum, and the newer control gels. The formulator will always attempt to keep his ink as short as possible to achieve the best lay, yet not so short that it will not follow the fountain. While the pastelike materials mentioned above are often referred to as compounds, for reasons of simplification we shall use the compound terminology only for those paste dispersions of materials that contribute to slip and scuff resistance in the final ink film, heading the list of these materials would be the various waxes, including the most widely used type, the microcrystalline waxes. The more of the latter that can be incorporated in the ink, the better the slip. However these waxes *cannot* be used in any ink that is to take a subsequent imprinting after the ink is dry. In these latter cases, compounds containing polyethylenes, polymekons, or other similar materials are used. These latter can be used in inks that are to be imprinted after drying. These compounds are also used to a great extent to control body and have the added advantage of contributing slip and scuff resistance.

Driers, as the name implies, are used to accelerate and control the rate of oxidation or hardening of the printed film. The choice of driers by the formulator will be directly governed by the overall composition of his ink. He will always seek to obtain the fastest drying possible consistent with press and stock conditions. Many times he will use inhibitors to control the rate of bulk and thin film drying without materially affecting the print drying. Printers, paper men, and ink men would be extremely happy if this subject of drying were as devoid of troubles as it sounds in the above analysis. Unfortunately the process is a chemical one and as such is extremely sensitive to changes in temperature, humidity, press conditions, paper variations, etc., and it is a constant battle to maintain proper drying.

Gentlemen, this about concludes our discussion on gloss ink components and unlike our hot-rod friend we hope that we do not have any parts either left out or left over. The perfect gloss printing job, like the perfect touchdown play, can only be achieved by each man carrying out his assignment perfectly and I'm sure that meeting like this one can definitely contribute toward that objective.

Paper for Gloss Ink Printing

Joseph Abelson

A REVIEW of printability literature reveals that print gloss definitely depends on the interrelation of ink, paper or paperboard, and printing conditions. The primary printing factors affecting printability, the printer can and has to control, are printing pressures, printing speeds, ink film thickness, temperature, and humidity. Whereas, the paper variables affecting printability are formation, surface smoothness, ink receptivity, caliper uniformity, and density. Since, as you can see from your programs, I work for a paper mill, I'll forget about the printing variables and the ink, and concentrate my remarks on where and how paper fits into the picture of printability and in particular as it is related to gloss ink printing.

While inks for high gloss must have certain special properties, (at least that's what the ink manufacturer always claims), ink gloss is also often thought of as being closely related to the ability of the paper to hold the ink on its surface. Fetsko and Zettlemoyer, in a paper given at the National TAPPI convention in New York, in February, stated that the most important printing condition affecting gloss is ink film thickness. This also has been reported by the Lithographic Technical Foundation. Undoubtedly, the ink and the printing conditions play a very important part in controlling the ink film thickness, but the paper also contributes by either a lack of absorptivity or too much.

Naturally, to get the best gloss assuming all else is equal, the paper with the lowest ink absorptivity will give the best results. However, no one stock is best, as the relative gloss tendency of a series of stocks depends on the ink and vice versa. Therefore, predictions cannot be based on a single empirical test measurement. The gloss holdout depends on a balance between ink setting and the pore structure of the sheet.

JOSEPH ABELSON, Arnold, Hoffman & Co., Inc., Providence, R. I.

It is, therefore, the paper manufacturers responsibility to give the printer a sheet of paper where the pore structure is most suitable for ink receptivity. The reason I use the words "ink receptivity" is that unless you had some ink receptivity you could not print at all. The classical method of controlling the pore structure of the paper is by hydration. This is a physical phenomenon which takes place during the preparation of the fibers for forming the paper web. The result of hydration is a much denser sheet of paper, where the individual fibers are in more intimate contact with each other, reducing the total number as well as the volume of pores or capillaries in the paper. This, however, has a detrimental effect on the opaqueness of the paper which to a large measure is dependent on air voids within the paper structure. Therefore, the papermaker is faced with an anomaly. The more hydrated the stock the lower the opacity. Or related to ink holdout, the better the holdout, (as caused by hydration), the better the showthrough. The ultimate in this direction is glassine paper which is very highly hydrated, but is not very opaque.

In order to counteract this effect, the use of fillers such as clay and titanium is common. Another factor the papermaker has to contend with in a highly hydrated stock is its ability to hold water. This reduces the speeds at which paper can be made. Needless to say, this is costly. Therefore, a happy balance has to be struck in order to give the printer maximum hydration, maximum opacity, and minimum cost. I do not have time to explore fully the beneficial and detrimental results of hydration. Suffice it to say that the degree of hydration is extremely important to the paper manufacturers. There are many ways in which hydration can be measured, but a very simple means is the measurement of porosity in the finished paper. This is done by noting the time it takes 100 cc. of air to pass through a given area of paper. The less porous the paper, the better hydrated the fibers are, and the better the ability of the paper to prevent the ink from penetrating too rapidly or too deeply into the sheet. As I stated previously, no one empirical test will give all the answers, and the biggest drawback to porosity measurements is that ink is absorbed by the surface of the paper, whereas, pososity measures the ability of air to pass through the entire thickness of the paper.

In order to give the printer the best possible printing surface, paper is surface sized. This is done on the paper machine after the paper has been partially dried and just prior to calendering. There are many reasons for surface sizing printing papers, but the main reasons are (1) improve the physical tests of the paper, and (2) improve the surface of the sheet—that is, to lay the fuzz, increase the smoothness, affect the ink absorption, increase the brightness or appearance, etc.

The actual surface sizing operation consists of either dipping the paper into a tub of starch or by spraying the starch solution onto the sheet. Depending on the viscosity and temperature of the solution and machine conditions, a certain amount of the starch will be absorbed by the paper. The improvement of the surface characteristics as I mentioned earlier, depends on keeping the coating or sizing on the surface and forming as continuous a film as is possible. In order to keep the surface size from penetrating into the sheet, high viscosity starches at low temperatures in combination with hard internal sizing of the paper are used. It is also possible, and in many instances advantageous to use starch derivatives such as ethers, or chemical additives such as polyvinyl alcohol, alginates, and carboxymethyl cellulose to name only a few, to improve the film forming properties of the starch.

To further improve surface properties, pigments can be put into the surface size solution, and combinations of starches, latices, and pigments can also be used. These treatments should not be mixed up with true coating procedures such as roll coatings, air knife coatings, trailing blade coatings, and similar techniques. I will leave that topic to my colleagues who work in mills that make coated papers. As I already stated, the purpose of these various techniques is to form a continuous (or at least as close to continuous as possible) surface film on the paper which will make a good barrier for hydrophobic materials such as printing inks. Another very definite improvement is the filling up of surface irregularities. Both of these results will give the printer a sheet of paper which will perform more satisfactorily when the desired end result is to keep as much of the ink film on the surface as possible.

There are several methods available to test the ink absorptivity of paper. None of these are in themselves perfect, but are nevertheless used by paper manufacturers as guides or controls. The most common are the Vanceometer which measures the rate of oil absorption on the surface of the paper. The various methods of using K & N ink, which is similar to printing inks. K & N ink is usually used in a qualitative measurement, where two sheets of paper are compared to each other.

However, I have had some success in measuring the brightness loss due to the absorption of the ink by the paper; and there are several methods of determining the amount of ink a sheet of paper will absorb by weighing before and after an ink application. The weight difference being the amount of ink the paper picks up. In the final analysis the best test presently available and the most accurate is the proof press used by the printer, or even better the final job.

In conclusion, I would like to summarize what I have said. Print gloss depends on the interrelation of ink, paper, and printing conditions.

Ink gloss is highly dependent on the thickness of the ink film on the paper and therefore to a large extent on the ink absorptivity of the paper.

The paper manufacturer controls the ink absorptivity of the paper by the degree of hydration and by the type of surface size he uses.

There are several testing methods available to measure the ink absorptivity of paper, but none are perfect, and are best used as controls.

Surface Coatings with Improved Printability

John O'Donnell

In the absence of printability defects, the properties of coated paper that effect printing quality are surface strength, wet rub resistance, opacity, brightness, smoothness, and refractive index of the coating pigment. How the paper coater controls these and other important properties are taken up in the following discussion on surface coatings and printability.

The primary requirements for printing paper or board to accurately reproduce the printing plate are that it be as smooth as possible, that it uniformly accept the ink to the desired degree, and that it have dimensional stability. In essence, these requirements are the reasons for coating paper as uncoated paper is uneven and porous, and even after supercalendering to achieve uniformity for printing, uncoated paper still exhibits considerable uneven ink absorption and reduced brightness.

LETTERPRESS VERSUS OFFSET

Before discussing coatings themselves, it might be well for continuity, that we take a brief look at the printing processes involved and their growth patterns.

Breaking down printing into the two largest processes, we have letterpress and offset. Letterpress is the older process and is still the most widely used. This consists of printing from a flat or rotary plate by means of an impression. The main forte of this process is in large volume printing (e.g., *Time*, *Life*, telephone books, etc.) and also, where thin stocks

John O'Donnell, Borden Chemical Co., N. Andover, Mass.

are to be printed, say under 13 lb./ream, letterpress is better for more accurate register.

Offset printing essentially consists in printing an image from a rubber blanket, and papers printed via this method must have "wet pick resistance." This is one of the most important problems facing the printer and papermaker today, and will be discussed in detail later on in this paper. The water and ink present on the rubber blanket both act as adhesives which tend to pull the coating from the paper. In web-fed offset, the water on the blanket can also lead to lateral misregister. This does not happen with sheet-fed offset because the sheets are fed cross grain. The strong point for offset printing is in the economics of the plate making process as well as the small amount of make ready to do the job. It is also possible to print a rougher surface more accurately. Both of these processes are growing, and sources estimate that today the ratio is about 75/25 in favor of the letter press. However, they see offset growing at a faster rate in the next several years so that the ratio will become 50/50.

Now for a look at the materials used in surface coatings for paper. Essentially, a coating color is a complex mixture of pigments and adhesives with defoamers, soaps, and preservatives added for good measure. The function of the pigments is to fill in the interstices of the paper, form a smooth surface, exhibit controlled ink absorption and impart brightness, gloss, and opacity. The purpose of the adhesive is to bind the pigment to the paper with sufficient strength to resist the shearing or "picking" forces developed at the printing press.

PIGMENTS USED

The types of pigments used in coatings consist mainly of coating grade clays, whiting, and titanium dioxide. The clays present an even (isotropic) surface as far as ink absorption is concerned, and do not degrade in brightness under supercalendering. The opacity of the sheet can be controlled with the amount of titanium dioxide in the coating, especially if the sheet is to be subsequently waxed. In general, the smaller the pigment particle, the more uniform the sheet is to ink absorption. By making use of different shaped pigment particles in a coating such as whiting (spiny, irregular shapes) instead of an all clay coating (plates) the void areas can be increased and still have uniform distribution with faster ink absorption and greater fidelity in high speed printing.

TYPES OF BINDERS USED

The main types of adhesives used today as binders for paper coatings are starch, casein, soy protein, styrene-butadiene latices, acrylic latices, and polyvinyl alcohol. A comparison of binding power efficiency and prices are listed below:

Adhesive	*Pounds of adhesive reqd. to bind 100 lb. clay*	*Approx. price/dry lb., $*
Starch	18–25	0.08–0.14
Casein	12–15	0.19–0.24
Soy protein	13–16	0.20–0.23
Polyvinyl alcohol (LEMOL 60-98)	3–5	0.57
Styrene-butadiene (POLYCO 350-W)	12–15	0.30
Acrylics (POLYCO 2718)	12–15	0.40
(POLYCO 2712)	10–12.75	0.50

The nature of the adhesive used as the bonding agent in a coating mix is, as you see quite important in determining the surface strength since the bonding strength of these materials vary over wide ranges. It has been found that bonding power varies from a material of somewhat low bonding strength like starch to a material like polyvinyl alcohol which has about six to seven times the bonding value of starch.

Starch is consumed in the largest quantities (approx. 80–120 million pounds) as an adhesive for paper coatings. Its low price is the principal reason for its high usage. The most significant development in the manufacture of starches for paper in the last ten years has been the ethoxylated starches. These starches possess greater resistance to gelling and retrogradation than most other types of starches. This has been proved by their commercial acceptance. The major drawback to starch is its poor wet rub resistance.

Casein is another natural adhesive used in large quantities (approximately 35 million pounds/year). It has a fairly low price with good binding power and can be insolubilized to yield papers with excellent wet rub resistance. It is used in most offset publication grade papers (all purpose litho type) and label grade paper. Mostly all cylinder board machines use a combination of casein and latex as the binder. Starch is not used for it does not have sufficient water resistance to withstand the water boxes used at the calender stacks without "milking."

Soy protein is widely used in high solids machine coatings because of its lower viscosity characteristics. However, this lower viscosity is achieved by a slightly lower molecular weight which reduces its water resistance and adhesive strength somewhat.

One of the most significant developments in the field of coating binders has been the development of the various synthetic latices. At present, the latices used are divided into three classes. The first class, styrene-butadiene, was the first used, and today still accounts for the highest percentage (75%) of the 40 million pounds (wet) of latex used per year for coating paper and board. The second most widely used group are the acrylics (20%) and the last group are the vinyl acetate type polymers (5%).

By incorporating either styrene-butadiene or acrylics into a paper coating containing casein or starch, the paper coater obtains an improvement in the following properties: (1) wet rub resistance, (2) smoothness (latex is thermoplastic and will cause the coating to smooth whereas natural binders are nonthermoplastic and do not finish as well), (3) dimensional stability (helps prevent lateral misregister in offset printing), (4) flexibility, (5) levelling of the coating color with improved printability, and (6) gloss.

The workhorse of the latices is the styrene-butadiene type. This is because of their low cost and all-round good properties. They are used in the large volume fields of all purpose litho papers, cylinder board coatings, label grade papers, and photographic coatings, etc.

The acrylics were first adopted for coating bread wrap paper where their low odor properties were of paramount importance. Their other properties were in general equivalent or slightly superior to those of styrene-butadiene latices. In most grades of coated paper, the coating represents a large percentage of the total weight, and mills are reluctant to pay a premium which so far has limited acrylics to specialty uses. Newer, softer acrylics with higher adhesive strength have recently met with considerable success in coating board where the coating is only a small portion of the total weight.

One of the most important of the newer types of binders that the author expects to be more widely used in the future is polyvinyl alcohol. Except for increased printing smoothness, better and more even ink receptivity is probably the most important advantage of coated paper over uncoated paper. The variable of a coating formulation, which most directly affects the ink receptivity of a coated paper, is the amount and nature of the adhesive in the coating color. The ink receptivity decreases as the adhesive content increases. At equal wax pick resistance, the ink receptivity of a coating containing a fully hydrolyzed, high molecular weight polyvinyl alcohol (e.g., LEMOL 60–98) is higher than that of starch or casein, and the brightness and opacity are also higher. The main problem to date with polyvinyl alcohol has been the development of fast wet rub resistance within the drying time alloted by the speed of the paper

machine. As the technology increases, it could become widely used because of its large drop in price from $1.50 to a current 57 cents per pound.

MACHINE COATING OF PAPER AND BOARD

The major types of machine coaters used today are the air knife, trailing blade, Champion, Consolidated, offset gravure, and Champion bar type coater.

The bleached board industry has gone exclusively to the use of a trailing blade and/or air knife which is preceded by a size press, whereas the cylinder board industry does not use the trailing blade at all. It uses a roll coater, air knife, or Champion.

For publication grade papers, roll coaters are the most widely used because they can apply high solids coatings at high speeds (little water to evaporate). The problem with roll coaters is in "pattern formation." Trailing blades are being installed after the roll coaters on newer machines which are being built to help eliminate patterning.

CURRENT PROBLEMS FACING THE PRINTER AND PAPER COATER

The biggest single problem that has come up recently has been in the development of wet rub resistant coatings more rapidly in high solids formulations with a minimum of curing (i.e., within the time alloted by the speed of the machine). This has become a problem because of the desire of fully intergrated mills to coat one day, and print the next in order to cut down on inventory and storage. The problem is known as scumming, or piling and when encountered, the printing press must be shut down and cleaned up. This has been attributed by many companies to insufficient water resistance. It is thought that the protein binder not being sufficiently insolubilized, is being emulsified by the ink and water from the blanket.

FUTURE

One of the foremost objectives of the chemical companies is to prepare newer synthetic binders which have increased surface strength and faster development of water resistance at a low price.

The ideal binder would be a material such as polyvinyl alcohol, and perhaps as the technology increases, the problems of faster water resistance and viscosity will be worked out.

Paper Surface Characteristics from a Printers Point of View

Robert Headley

Today we have many different paper surfaces to choose from. There are bonds, ledgers, indexes, bristols, and tags which are the harder surfaces of papers; then there are vellums, offset, text, book papers, uncoated books which are the softer types of papers. We also have various types of coated papers available.

Letterpress printers can use some of the surfaces that offset printers can't use, and the offset printer may use paper finishes or surfaces that letterpress printers cannot print on very well. When the letterpress printers have to print a halftone on some of the rougher surfaces such as the vellums or antiques or most of our text papers difficulty is experienced in printing a smooth halftone. Therefore, it is important that the paper surface picked for a job be right.

I happened to see a saddle-stitched pamphlet with a 10 point cast-coated cover printed in a solid blue on both sides. Even though it was scored on the fold it had cracks which stood out like a sore thumb. When printing on coated paper having folds, we have to try to avoid having printing in the folds. Printing in the folds have a tendency to crack or powder and thereby makes your printing surface look sort of ragged.

Another thing is an advertising piece printed on a vellum or antique stock with a solid black reverse on the cover. At the same time it is used as a counter piece and it is handled by the public especially by a woman. Did you ever see what it would do to a woman's white glove? Some of those things should be avoided.

Now, the question is, will it print? The big question is printability. Naturally the best test is the pressroom. Selection of the proper paper for the purpose remains the responsibility of the paper buyer and the paper user. Therefore, the printer takes it for granted that the paper that reaches the pressroom is press worthy.

Will it print without trouble? Will it absorb ink quickly enough? Will it print without picking or leaving spots in the solids. This is one of our biggest bugaboos.

When making paper for rotogravure, letterpress, or offset, the offset paper gives the paper manufacture the biggest problem. You will have to realize that the offset press squeezes the whole surface of the paper against the rubber blanket, while applying water and greasy, tacky ink at the same time it is being pulled off the press at high rates of speed. Therefore, it is pulling the paper out of shape all the time.

The proper sized paper has to be used in offset, rotogravure, and letterpress printing. Coated stocks are especially sized for offset to resist water during printing. This is not necessary for coated papers used in letterpress or rotogravure printing. Uncoated offset papers are made with a harder finish and calendered down more than letterpress papers. Softer surfaces can be used in letterpress, but not in offset. The softer the paper surface the higher the ink absorption. The harder the paper surface the less ink absorption. You take your tags, your index, smooth bristols you may have to change your ink, and make your ink a little bit different from the ink used on the softer surface sheets because it lays on the top much more. Another thing is trying to print solids. Sometimes your ink may lay on the surface and the hard spots in your tags or indexes give you a mottled effect. You have hard spots on these paper surfaces and nine times out of ten if you don't use an offset spray those hard spots are going to offset on you. Now your softer papers, your vellums, text and antique stocks, they are a little bit different to print on. You can use a softer ink. It is much simpler. You do not have to worry too much about the offset problem.

The big problem mostly is to print without picks, hickies, or spots in the solids. This is one problem offset would like to overcome. Now I mean hickies, I am not referring to the hickies that come out of the ink or the rollers, but the ones in paper surfaces. I am referring to a job 26 × 40 ten point coated stock. You have about 8-8 × 10 solid black panels with a plain black and white job. In the process of making ready and when you are all done you seem to have problems getting all the spots out of these solids. You can't keep them out. Your run a few more sheets, you still have spots in the solids. So you run some more, the spots still do not go away. The paper man says you have to go back through your sheets and see if you can find about where its being picked off. If the coating is picking off the paper then it isn't just plain paper dust from the cutting or I would say the poor housekeeping of the paper manufacturer.

Another example, you have a financial statement booklet to be made and you have a lot of solids and color on the booklet. You pick out a nice vellum or antique stock for the booklet. You have the same problem there, the most important part is to get those solids on there smooth and even. Sure, if we have trouble with laying it on smooth and even as you say, we can doctor the ink. That's the biggest bugaboo the inkmakers don't like. He doesn't like you to doctor his ink and I can agree with him. The minute you start doctoring your ink you start killing the quality of your print-

Robert Headley, Philadelphia Litho Co., Philadelphia, Pa.

ing. If you soften the ink too much you have a tendency not to print as sharp and the image spreads more. You start to fill up the reverse on your solids. It is important that they stay open and clean.

An offset paper with a slight tooth so that it isn't too smooth and a wax test of 9 to 11 and with just enough ink absorption so that it will print the halftone dots sharp and not spread is an ideal surface for offset paper.

For your specialty advertising pieces your text papers do a very good job. They give you very little trouble in printing. Also handmades and fancy finished papers will add sparkle to the job.

Putting it all together, I think the paper manufacturers are doing a pretty good job. I remember when printing coated paper by offset was rare and quite a problem. Today it is taken for granted. You can see all these changes for the good came about in my time and I don't think I am that old. Paper was made in China as early as 105 A.D. Figuring it was made that long ago, we wonder why its not perfect by now.

To get the proper perspective I will read a piece from Richard Carryington. Richard Carryington, in "The Story of Our Earth," suggests the greatest magic trick of them all: Let us imagine that, by some magic, the whole of earth's history could be compressed into a single year. On this scale, the first 8 months would be completely without life. That would run into September. The following two would be devoted to the most primitive of creatures. No mammals would appear until the second week of December. "Man, as we know him, would strut onto the stage at approximately 11:45 p.m. on December 31. The age of written history would occupy little more than the last sixty seconds on the clock."

That ought to help you to reduce current paper problems to the proper perspectives.

The Influence of Paper Surface Characteristics on Printing Inks and Their Formulation

Joseph Krause

THE formulation of a printing ink is dependent upon many varied factors. The more important basic ones are; the method of printing, the type of press and its speed of operation, the kind of surface being printed, the manner and speed of drying, and the end use requirements of the printed matter.

The most important combination of factors governing this area of technology is the ink-paper relationship. This phase of mechanics has been the object of extensive study by many researchers, embracing the graphic arts, both here and abroad, throughout the years and though much basic knowledge has been brought to light, the studies have raised more questions than answers.

This concept, termed printability and with which we are concerned in our discussion here, is not a simple on to evaluate and no single index has yet been found to enable us to measure and control it. The main objective of printability is print quality. Print quality takes in three distinct, but closely interrelated areas of appraisal and investigation, namely, printability of paper, printability of print inks, and presswork.

Printability of paper is related to smoothness under printing pressure, ink receptivity, and surface bonding strength.

Printability of printing ink is concerned with the working properties of the ink, which include viscosity, thixotropy, tack, and length, and the optical properties, which comprise color, transparency, and covering power. Presswork relates to printing pressures or so called makeready, etc.

Because of time limitations, this ink-paper relationship will be discussed in a very broad and general way, with particular emphasis on the fundamental involved in the letterpress or typographic method of printing.

An ink is generally made as tacky and heavy as the stock will allow without picking or rupturing of its surface. It is also made as strong or concentrated in color as possible, to allow deposition of the thinnest film, consistent with the ink receptivity characteristics of the stock surface. Its viscosity or tack must be correspondingly reduced as the speed of the press is increased, as the caliper and weight of the stock is decreased and as the printing form is increased.

From these broad generalizations, it can be deduced that inks designed for hard stocks like bond and ledger, will be quite heavy and tacky, while those for use on the softer types, such as coated machine finished or news, will be proportionately softer and less tacky in body or consistency.

Rough or uneven surfaced stocks require heavy and short bodied inks, because heavier printing pressures are necessary to force the ink into the depressions and to resist the squeeze out and formation of ragged edges and mottled effects. Because of the greater surface areas exposed, more ink must be carried to attain full coverage and consequently the inks must be weaker in color strength. To further prevent uneven and mottled printing, they are made as opaque as possible.

The drier requirements must also be considered very carefully. The sulfite bonds because of their partially absorptive nature will require less drier, while the relatively nonabsorptive rag bonds and ledger types will not only need more drier, but in many instances may necessitate the use of synthetic resin based vehicles, in order to effect proper adhesion and surface dry of the film. Other additives, such as waxes, starches, and talcs may be incorporated to minimize sticking and setoff in the printed piles.

Vegetable parchment stocks require the use of quite heavy and tacky inks, because of their rough texture and hard surface. The glycerine content of these stocks tends to retard drying vehicles in essential in their formulation. Glassine stocks are similar in this respect and the same rules apply except that softer inks are used, because their surfaces are smoother.

Surface hardness irregularities, or nonuniform porosity such as may exist in certain index and sulfate type stocks present difficulties that cannot always be overcome through corrective formulation, particularly when a specific effect, such as gloss, for example, is requested. The hard, high spot areas, being nonabsorptive, hold up the finish or gloss, while the soft low spot areas absorb it, resulting in a badly spotted and irregular color surface effect. Overprint varnishing of the job or a changeover to a completely dull or flat ink, are the only alternatives that can be resorted to in such situations.

The very soft and highly absorptive stocks like newsprint, for example, require very fluid and tackless inks. Drying is generally accomplished through absorption and metallic driers are seldom if ever used, particularly where the conventional blacks are concerned. Because of the fluidity of the inks and the high porosity of the stocks, strikethrough and showthrough, types of stain effects, due to this penetration, are quite commonplace. Nonstaining oils, blended with proper ratios of resin and pigment, consistent with very low material cost, must be carefully compounded together to minimize these difficulties. Misting and flying of the inks in high-speed news printing is another source of trouble, and gelling or shortening agents must be added to over come these tendencies. It is quite obvious that proportionate reduction of tack and viscosity of an ink, with corresponding increase in paper softness, is not always a simple matter and that broad knowledge and expert ability are required in the formulation of even the simplest types of inks.

The smoothness of a stock greatly influences the printability of an ink and the attainment of high print quality. The smoother the surface, the less pressure is needed for printing and consequently less ink can be carried to obtain

JOSEPH KRAUSE, R. W. Rexford Co., Philadelphia, Pa.

proper and complete coverage. This is conducive to the printing of fine halftone screens and delicate line-cuts and type with a high degree of fidelity of reproduction. High concentration of color, to allow spare impression is therefore essential, if screen fillup, mottle, and setoff difficulties are to be avoided.

Coated papers possess this quality of smoothness, but because of the limitations governing the adhesion of the coatings to the body stocks, they tend to pick rather easily, necessitating the use of thin bodied and tack-free inks. The coatings are inherently absorptive, and poor drying, in the form of chalking, could easily result, due to excess drainage of the vehicle. The proper combination and amounts of metallic driers must be carefully compounded into these inks to retard this effect and assure thorough dry. The poor surface bonding strength of these stocks, particularly the machine coated varieties, requires the use of hard drying, resin based vehicles and hard wax compounds to reinforce them and provide the necessary resistance to scuffing in the folding, cutting, and handling operations of the printed pieces.

The excessive absorption characteristics of the cast coated papers, in particular, demands the utilization of high gloss retentive vehicles, to keep the ink on the surface. Conventional coated paper inks produce flat effects and chalky films of poor scuff resistance when used on these stocks.

Inks for plastic coated and lacquer treated metallic foil papers may dictate the use of compatible solvents in their formulation to effect partial solvation of the surface film and impart the necessary bite to achieve proper ink receptivity and adhesion after drying. The plasticizers that may be present in the surface films of some of these stocks, may migrate to the top and produce a bleed effect around the borders and edges of the printed image, which would indicate that a careful choice of nonbleeding pigments must be considered, when formulating such inks.

The color of the stock can produce a drastic color difference in the finished print, with a given ink. The use of opaque and brilliant pigments is highly essential in the formulation of inks for these stocks. The degree of discoloration increases, as the absorptivity and roughness of the stock increases, as the film thickness decreases and the transparency of an ink increases. Silk screen inks, because of the heavy deposits applied, naturally are least affected, in this respect, with rotogravure, flexographic, letterpress, and offset lithographic inks following, in that order.

Whiteness variations of white stocks can also produce notable color differences, in the printed films, particularly where pastel shades are concerned. The color differences, as with colored stocks, become greater as the roughness and absorption characteristics of the stock increases.

Chemical residues present in paper have been known to cause bad effects on inks and printed films. Thec hemicals left in paper, due to incomplete removal or by their presence, in the pastes or glues, during its manufacture, such as for example, acids alkalies, sulfur dioxide, chlorides, and the antichlors, sodium sulfite, and sodium thiosulfate, can cause the following troubles:

1. *Discoloration of Inks.* Sensitive pigments, for example, irnn blue and ultramarine blue, may partially discolor in alkaline or acid papers when excessive moisture is present. Another example is the reduction of organic pigments and fading of chrome colors by sulfur dioxide in the presence of chlorides and moisture.

2. *Tarnishing of Gold Inks.* The formation of a film of black copper sulfide over the bronze powder particles, is caused by the presence of reducible sulfur in conjunction with moisture and acidity of the paper.

3. *Retardation of Drying.* This can be caused through the insolubilization of driers in the ink by the acidity of the paper during periods of high humidity. High moisture absorption or permeability of certain stocks can retard drying even in the absence of acidity. Certain cationic and colorless fluorescent dyes, derived from triphenylmethane, currently being used to whiten and brighten papers, are other troublesome sources responsible for drying difficulties with inks.

4. *Sensitization of Lithographic Plates.* Aluminum sulfate or alum residues in the paper can be extracted by the dampening water, on a lithographic press, to give rise to scumming and tinting of the nonimage areas of zinc and aluminum plates.

5. *Crystallization Effects.* Some sizes and pulps or body stock used in papers and boards, change the surface characteristics of a printed film of ink, to make it nonreceptive to overprinting and adhesion of another ink. This condition can be corrected by drastically modifying the overprint ink with solvents and waxes to produce a short, heavy ink that stays put without crawling and allowing the solvent to open the film and thereby effect a better grip or bite to its surface.

I hope the foregoing will prove helpful to you in gaining a better understanding of this subject and provide enough stimulus to start questions popping in your minds. Perhaps we may all benefit from these reactions.

New Developments in Graphic Arts

A. E. Sterner

Any discussion of new developments in the graphic arts leads to predictions and predictions lead to getting your self out on that proverbial limb.

Sir Winston Churchill made a remark that fits this situation beautifully. He was asked what are the qualifications of a politician? Mr. Churchill answered: "A man who tells you what is happening today, what is going to happen tomorrow, next week, next month and next year. And then when it doesn't happen, tells you why!"

Gentlemen, so much for the situation I find myself in this morning. I would like to discuss briefly with you developments in our industry in three phases.

1. Past—for background.
2. Present—developments and trend to future.
3. Blue sky—our space age future.

The logical place it seems to me to start is the period just after World War II. I feel that it was at this point we in the graphic arts were on the threshold of an entirely new era in the industry. For the years immediately following World War II up to 1950 the industry was catching up on all phases of its operations. Old equipment had to be replaced. Materials, inventories had to be replenished and materials upgraded. Personnel coming home from wars had to adjust to civilian life and be retrained.

From 1950–56 three major changes started to take place. Things really started to happen fast. We are all aware of this I am sure, but I wonder how many realize the magnitude of this change? The major areas of change were as follows:

Competition in the graphic arts really became keen among American equipment manufacturers. European industry as it began to rebuild from the war added to this competition. New ideas, new models, designs, and modifications were made. Intertype, Lanston Monotype, and Mergenthaler and others all raced to get photosetters perfected.

The field of offset lithography really started to come into its own, growing in leaps and bounds. The number of employees between 1950–56 increased 74%. Manufactured (value added) between 1950–56 increased 110%.

To bear out this activity, yes, I would call it a revolution. We need only refer to the Census of Manufacturers tables showing values of shipments of printing, machinery, and equipment.

1947–50 shipments increased at rate of $3.3 million per year
1950–54 shipments increased at rate of $7 million per year
1955 shipments increased at rate of $19 million per year
1956 shipments increased at rate of $29 million per year

A. E. Sterner, Allen, Lane & Scott, Philadelphia, Pa.

What new developments and changes have been brought about because of this revolution within our industry? Well, let's list a few.

1. Most important for future development—research facilities have become firmly established and are continuing to grow.

2. Photo type setting, electronic scanners, and engravers. Powderless etching, the quick etch, and many others have gained wide acceptance.

3. Web offset, formerly used for forms work almost exclusively, has been developed to the point it is now competing in the catalogs and mailer, magazine publication, and newspaper fields.

4. Every day in our shops we are using the services of electronics such as exposure timing in our camera and plate making areas. Checking densities, controlling temperature and humidity, web and ink controls on press equipment. Controlling skids heights by a beam of light in our binderies and many others.

We have also seen during this period the entry of many large nongraphic arts companies into the field of basic research. As an example:

1. E. I. du Pont and the "Dycril Plate."
2. Minnesota Mining—presentensized plates; pre makeready system; sleeve dampening method.
3. R.C.A.—color scanner.
4. Many others.

5. Colleges and universities have become active in training men in quality control and other graphic art techniques. Rutgers, Rochester Institute of Technology, Carnegie, Lehigh, and others.

So much for the changes that have, or that are still taking place.

PREDICTIONS OR TRENDS BASED ON PRESENT DEVELOPMENTS

We are all striving to eliminate variables. Because of this continuing effort and materials that have been developed we can expect to see the following trends expand.

1. Lithographic plates will tend more and more to be precoated. This will include positive and negative working plates. Precoated deep etch plates may be developed.

2. Photography—color separations will be handled more and more by electronic scanners. Recent tests indicate this is profitable both economically and quality wise from reflected copy.

3. Letterpress can be expected to continue toward the development of high-speed rotaries, using quick etch or photo sensitive plates.

4. Offset presses—manufacturers and researchers will continue to try to find ways to improve if not eliminate the dampening systems as we know them today.

5. Inks—we can expect new and improved pigments to further the goal of balanced inks. As offset dampening systems improve, and we use less and less water, softer inks should find wider acceptance. Almost instant setting inks will be developed.

6. Paper—efforts will continue toward developing treatments for paper that will make them more dimensionally stable. Economical synthetic fibers could also supply the answer of stability.

Within the realm of possibility is the merger into one process of letterpress and lithography. Such a process might use a shallow etched plate of metal or a photo polymer material printing to a relatively tough, but resistant disposable blanket.

Space Age. Let's really go blue sky for a few moments. In the field of composition an electronic marvel has been developed called the Farrington optical scanner. This instrument will read a page of typewritten copy, including upper and lower case letters, numbers, and common punctuation marks at the rate of 200 characters per second.

The characters are translated into a punched code on paper tape. Such a tape can be hooked up to a typewriter, a photo composer, a hot metal machine, or any thing else you may design to be tape operated.

The machine will feed up to a ream of typewritten copy automatically.

One of the engineers that developed the machine stated that there were 50 sensing circuits. Only 11 were being utilized. The remaining circuits could be used to actuate the machine to justify lines, etc. The variations seem unlimited, but it would be costly.

Ten years ago we might have considered trips to outer space and the moon fantastic! Today, however, it seems almost a reality.

The manager of the Lithographic Research Foundation, Mike Bruno, visualizes the printing process of the future as:

> "A cathode ray tube like a TV camera which scans the original and transmits impulses to a similar tube which produces a changed image on a sheet of paper." The changed image is then converted to a visible image by treatment with self-fixing towers. This could very well be the system by which our space explorers can show us what is going on in space."

With machines such as the Farrington optical scanner being developed in just two years from an idea to operating machines it is not hard to see how industry and research can make such visualizations possible.

New developments in the graphic arts, gentlemen, they are unlimited.

Individual success, however, will depend on open mindness and aggressive application of new methods and developments.

Our future depends on you!

The Screen Process

Herb Sperry

Screen process, by far the oldest of our printing methods, has in the past 10 years experienced the greatest growth in techniques, equipment, and horizons in graphic arts history. Through the years a full realization of the merits of the process has captivated the interest of artists and designers looking for unusual means of decorating their creations. Screen printing as such, therefore, was wholly dependent upon the artistic ability and skill of the craftsman who prided himself on his ability to exploit color to the extreme.

Through a natural sequence of events, these craftsmen were soon called upon to print on or decorate shapes and surfaces not practical by any other means. Rough, smooth, soft, hard, flat or curved, convex, concave, embossed, debossed, thick, thin, square, round, cylindrical, and in sizes from 2 in. to 20 ft. Hence the stimulating expression "we can print on anything, even running water" as has been demonstrated. Naturally, the skill and ability required to perform the unusual, developed a special breed of craftsmen, with their secret methods and "goldberg" equipment.

These facilities attracted people with all sorts of reproduction problems and the headache-prone screen printer soon found himself running a service station and becoming so engrossed in his daily challenges that he forgot the fundamentals of running a business. He was selling a method and finally discovered that his entire future was dependent upon finding enough people with problems. It was also apparent that his output was limited to his own capacity or those of a few self-trained helpers. The only logical hope for growth and expansion would seem to do more of the thing that he did best, inevitably leading to specialization. The very obvious potential in each of the newly opened avenues, soon captured the interest of the more sales-minded business man who soon found ways of selling the product rather than the method. New interest, new customers, and new fields such as:

Herb Sperry, Color Process Co., Inc., Philadelphia, Pa.

Web printing of textiles and wall paper requiring special equipment for multicolor printing in continuous lengths.

Decalcomanias 100% screen processed and the newly developed pressure sensitive films and transparencies requiring precision presses capable of high speeds and long runs on temperamental and difficult to handle paper and plastic sheets.

Ceramics, with many areas of diversion including glass closures. The unbelievable shapes and sizes of these products, particularly for cosmetics have required great ingenuity in the development of high-speed screen printing equipment for the delicate printing in multicolors, durable enough to withstand abuse.

Wood and metal toys and kindred products in all sorts of crazy shapes and sizes.

Corrugated board, screened, die cut, folded, and stitched for supermarket bins and displays.

Posters, signs, paper, and cardboard point of purchase displays of every conceivable kind demanding the best in design, to better exploit the impact of color, possible by screen process. This type of operation is most likely to be equipped with the latest and largest darkroom camera, a variety of screen printing presses, roller coating machines, die cutting presses, riveting and stitching equipment and provisions for easeling, assembling mounting, packing, and shipping. Undoubtedly the greatest improvements in equipment for screen printing have been made for use in this flat printing field. Presses both flatbed with vacuum and cylinder, in sizes from 11 × 14 to 50 × 80, in speeds from 500 per hour, hand-fed, to 4000 per hour, with mechanical feed that will handle any thickness in the flat, including sheet metal, plastic, foil, cloth, paper, cardboard, etc.

The greatly advanced speeds in printing great areas of color are useless however, without adequate forced drying provisions and here too development has been gratifying.

By use of these improved facilities screen colors can be applied to plastic and foils competitively for cartons and packaging. Beautiful colors in lacquers, brilliant metallics and the popular fluorescents, capable only by screen process, afford much greater latitude in package and label decoration.

The newest and most dramatic field for screen printing is in the vast electronic field. The highly specialized and somewhat hazardous radium printing for dials, chasis and parts identification and coding, but most important for circuit printing. By printing a resist on metallic laminates and subsequent acid etching or by screen printing the actual silver circuit, instruments in extreme miniature can be designed, so complicated that they could not possibly be wired by hand. Hearing aids, missile and space vehicle controls, computers and of course radio, television, and business machines for dependable and foolproof service.

Unlike other methods of reproduction, limited to the printing of flat, receptive surfaces and chemically restricted inks, silk or metallic screens will pass any spreadable liquid or paste and make an impression on almost any surface or shape.

The future in the collective fields of screen process is limited only by imagination, and as science develops new products and methods in other industries, screen process will keep pace as always.

The Chemical Industries' Contribution to Improved Utilization of Wood

Donald V. Redfern

The chemical industry has made rapid strides during the past few years in its aid to the wood industry, both in helping to decrease the unit cost of production and the manufacture of new and improved products. The economic necessity of using more and more of the tree is now a reality, and our economy is tending toward one which requires the use of all the tree in order to have profitable operations.

This is particularly true on the pulp and paper industry, and I shall discuss several areas. There is a large amount of so-called wastepaper, such as paper returned from the consumer market in the form of newspapers, cartons, magazines, and also re-usable paper generated within your own mills and converting plants. With the addition of resinous materials and improved sizing agents to these wastepapers, molded pulp food containers of superior quality are being produced. They have high strength levels at high humidities and permit greater usage in the cold storage of fruits, meats, and eggs.

Another large consumer of wastepaper is the production of bogus corrguating medium. The chemical industry's contribution of improved wet strength resins, waterproof corrugating adhesives, stiffening agents, vapor barriers, and the like have all combined to assist in the manufacture of corrugated containers for fruits, produce, meats, and dairy products, which can be stacked in storage without sagging or bursting under humid conditions. Many of these same contributions, plus greaseproofness and decorative coatings, have increased the utility of paperboard, which is another major use of waste. In addition, increased dry strength and adhesion by resin addition improves the quality of board for typical applications, such as dress boxes, bookbinding board, and automotive board.

The most efficient use of the basic raw material in the manufacture of paper has drawn the attention of the chemical industry. Excessive sewer losses represent both monetary losses and contamination to the waterways receiving mill effluent. Alum and animal glue have long been recognized as aids to filler retention and improved efficiency to saveall systems. In the past few years, however, many synthetic materials have been developed, which are outstanding in their ability to retain fines and fillers in the sheet and greatly aid the recovery system. Modified polymeric urea-formaldehyde, polyacrylic, and polyamide resins are among the proved materials in this application. The reduction of fines and fillers in the machine white water is really incidental to the primary function of providing a better sheet. Improved retention is generally accompanied by more uniform distribution of fines and fillers. Paper of improved printability and optical properties is the result.

With the emphasis on increasing the total consumption of the tree, one of the most direct means is to increase the pulp yield from the wood used. The past few years have seen a major trend with the advent of high yield chemical pulps, improved semichemical pulping processes and cold soda chemimechanical pulping of chips. Reductions in both chemical and power costs often accompany these high yield processes.

Here I would like to look into the future and suggest that mechanical paper *per se* will be manufactured and used in high volume. The chemical industry will contribute to this by using resins to substitute for the fibrillation, which is now considered necessary in the fomration of a good paper sheet.

Agents, which promote interfiber bonding, are at present making high yield pulps more attractive. Corrugating medium, linerboard, and molded pulp of high stiffness and strength are obtained by incorporation of beater-add resins. Battery separators of excellent physical strength, porosity, and chemical resistance are possible by impregnation of semichemical sheets with phenolic resins.

It is possible that in grades of blended chemical pulp and semichemical or mechanical pulp, the amount of chemical pulp required for strength properties can be substantially reduced by additives, which will enhance the initial wet web and final strength properties of the sheet. These are just a few steps in the direction of eventually producing mechanical paper as I envision it.

Chemicals and resins will also make the surface properties

Donald V. Redfern, Vice-President and General Manager, American-Marietta Co., Seattle, Wash.

of these sheets attractive and functional, and right now grades of paper otherwise unusable to the printer or package manufacturer can be made from high yield pulps by proper surface treatment.

A corollary of improved strength and greater yield from pulp sources lies in the use of chemical additives, which will maintain desired sheet properties at lower basis weights. Improvement in tensile and burst strength as much as 15 to 20%, with resinous materials at levels around 1% in some grades, allows the reduction of basis weight, if these properties need not be higher in the final sheet. Other polymers contribute to fold endurance, tear strength, and elasticity.

The use of aids to interfiber bonding can substitute for beating in developing strength properties in paper and saving time and horsepower in the beating process. Freer stocks can be the result of this, and machine speeds are then increased. Retention aids, which increase the filler content and improve filler distribution, allow the production of printing papers of high opacity and brightness at very low basis weights.

The chemical industry, in turn, uses products of the pulp and paper industry in manufacturing its own materials. An example is bark, which is used for plywood adhesive extenders and soil conditioners. You are all very well aware of the products derived from waste liquor, such as ethanol and yeast by fermentation. Waste liquor fractions give us adhesives, foundry core binders, and surface-active agents. Right now Crown Zellerbach is producing dimethylsulfoxide and, of course, tall oil is a by-product of the southern pulp industry. Exhaust gases lend themselves to the recovery of sulfur dioxide.

There is a tremendous field left in the broader utilization of so-called waste products from your industry starting right in the woods and leading through to the finished product. The chemical industry is definitely interested both because it has a need to aid you in improving your unit costs and because wood is, and should be, a great source of chemicals in the future. There are certain basic problems, which need to be overcome. Nonuniformity of fractions derived from the wood and the complexity of the recovered fractions, whether they are produced chemically, semichemically, or mechanically, produce problems. However, I am confident that by working together we can solve these problems and produce economically sound technical advantages for the chemical industry in the use of products from wood.

In summation, the chemical industry and the pulp and paper industry are economically entwined forever and together have a great future in the production of new and useful products of commerce. In order to accomplish this, however, the requirement of close cooperative effort and better understanding of each other's problems is a necessity. Better definitions of what the future holds for the pulp and paper industry and the type of new products required by the customers is a must before the chemical industry can provide its share in producing our future products.

Some Aspects Involved in Refining High Yield Pulps and Reject Pulps

John T. Henderson

Better utilization of our forest resources have led the pulp and paper industry to the field of high yield pulping. In past years the objective of pulping was to purify the wood cellulose by removing lignin and hemicelluloses. In recent years pulping has ceased to be a purification process and has become a process of preparing a pulp for a specific use. These pulps contain more lignin and hemicellulose than normal pulps and in many instances give superior grades of paper. The increased yield also helps to reduce production costs and make paper products competitive with other materials.

High yield pulping has developed from the conventional pulping processes and normally uses shorter times, lower temperatures, or lowered chemical concentrations. High yield kraft pulps have found use in linerboard, and other unbleached kraft grades where brightness is not a singificant problem. Pulp yileds up to 60% are not uncommon. These pulps do not defiber completely on blowing and must be mechanically defibered. The strengths obtainable have been said to be better than normal pulp and in other cases poorer. Both points of view are true when the end use requirements are considered. Also, differences in the systems used to defiber high yield pulps can ban have a great effect on final pulp properties.

Also on the alkaline side of high yield pulping is the cold soda process for hardwoods. The conditions of temperature, caustic concentration, and time may be varied considerably and the resulting pulp ranges from a product similar to groundwood to a full soda pulp. Here again refining is critical and bears careful attention. These pulps are finding use in corrugating medium and printing papers.

Still on the alkaline side but utilizing sulfite the neutral sulfite semichemical process (NSSC) which produces pulps from hardwood for fine papers and corrugating medium. The corrugating medium produced by this process became the standard of quality in less than ten years. More recently softwoods and mixtures of hardwood and soft wood have been successfully pulped by this process or variation thereof. Jujo Paper Manufacturing Co. in Japan is producing newsprint using a high yield neutral sulfite as 30 to 40% of the furnish. Paper machine speeds are equivalent to the fastest machines in the world.[1]

High yield, acid sulfite pulping is beginning to come to the fore and there are now a number of mills operating on this process. The pulp is replacing unbleached sulfite in many grades of paper. Yields of 70% are quite common and in most areas this reduces wood costs by $10 to $15 per ton of pulp.

Many reject pulps which come from the screening operations are quite similar to high-yield pulps. These rejects contain a great deal of partially cooked fibrous material in addition to portions of knots and bark. These rejects can be refined and cleaned and the resulting pulps resemble high-yield pulps which can be used in many grades of paper. The refining techniques employed are important if we want to produce the best pulp possible from these materials.

Refiner operating conditions have been found to be critical in defibering both high-yield pulps and pulping rejects. We have found numerous cases where improper defibering has led to strength losses of 50 or 70%.

The following examples have been selected to show what can be done with a refiner by varying the operating conditions in a few ways. The examples also show that on many cases reject streams of less than one ton per day can be converted to a premium grade pulp.

The majority of this work was done with a 12-in. Sprout-Waldron refiner. A few examples are from the 36-2 Sprout-Waldron refiner and the Bauer 411 refiner which are all in our laboratory.

Groundwood rejects are refined in most groundwood mills, but there is some question as to how well this is being done. Groundwood rejects have been refined in the small laboratory refiner and pulps have been produced which are superior to normal groundwood from the same mill. These pulps are 10 to 25% better in all strength properties than the normal groundwood. These results have been duplicated on the larger refiners in our laboratory and mills. Thus there are refiners available for a small mill who has a half ton of rejects and for the larger mills who have 15

John T. Henderson, Project Leader, Central Research Department, Crown Zellerbach Corp., Camas, Wash.

[1] Eberhardt, L. E., *Paper Trade J.* 144, No. 8: 34–36 (Feb. 22, 1960).

or more tons per day. After settling the basic question as to which refiners were suitable for refining groundwood rejects we investigated some of the ways in which these refiners could be operated.

The initial method was to limit the feed so as to permit the refiner to produce a pulp of 100 ml. C.S.f. The question as to what happens when the feed rate is increased was investigated on both the large and small refiners. To maintain a constant power load the plate clearance had to be increased. Beyond rather narrow limits the freeness rose rapidly and strengths fell. The method of screening out the acceptable pulp and re-refining rejects from this latter situation was tried. The resulting pulp was very free and long fibered. Strengths were not good and low tearing resistances were particularly surprising. This work should be repeated using a screen more suitable for groundwood.

Sulfite knots have also been refined in a similar series of experiments. The results are similar to those on groundwood and indicate that refining in one pass at a capacity which permits both plates to act on the fiber bundles is a satisfactory way to operate. A trial on the Bauer 400 in Camas mill gave much better results than those obtained on the laboratory refiner.

Sulfite flat screen rejects have been refined by the same series of experiments. The results are again similar and the best pulp is approaching normal sulfite strengths. Centri•-Cleaning was tried on this pulp and the results are good. Freeness, burst, tensile, and appearance are all improved. When using wider clearances it is interesting to note that the burst, tear, and tensile are considerably lower at a slightly higher freeness.

The refining of kraft rejects again shows the same trend. Refining at close clearances, and centrifugal cleaning the refined pulp is a good way to operate. At a very slight drop in freeness the physical properties and appearance were greatly improved. This pulp also retains its tearing resistance on subsequent beating to a constant freeness level better than the other pulps.

The effects of plate patterns were studied and it was demonstrated that a plate which had a brushing action operated against a wide bar plate had considerable promise if operated at relatively close tolerances. When operated with a cutting edge toward the wide bear results were rather poor.

The above experiments have merely scratched the surface in this area of defibering and refining high yield and reject pulps. However, when a system is properly designed and operated it has been shown that good pulp can be produced for unbleached grades of paper. The following points are now felt to be of importance in the refining of the crude pulps.

1. The refiner must operate at close clearances to enable plates to separate fibers. Refiner must be sized to permit operation in this manner. Rubbing fiber bundles together or subjecting them to turbulence is not a sufficiently strong action to defiber them. The longer treatment required leads to excessive cutting of the fibers in the equipment used in this work.

2. Plate pattern is important. It probably varies for every specific job and it should be investigated as a function of each operation.

3. After refining a pulp contains some small fiber bundles and dirt. Screening is not an effective way to remove this material. Centrifugal cleaners are required for such a job. Screens can be used in the system to remove large shives and prevent plugging of cleaners. This condition should exist only when the refiner is being started up and shut down or when the plates are worn out.

In closing I would like you who are concerned with pulp mill operations to ask yourselves two questions. First, are we wasting part of the trees that could profitably be made into paper, and secondly, are we obtaining the highest quality pulp possible from our high yield or reject pulp refiners.

Availability and Use of Wood for Pulp in the Pacific Northwest

John B. Grantham

THE pulp industry of the Pacific Northwest obtains its wood requirements as logs, cordwood, and chips of many species from a variety of sources. In providing an outlet for such a variety of raw materials the pulp industry has contributed greatly to improving utilization of the region's forest resource. However, use of so many types of raw material complicates the task of analyzing the industry's current and future wood requirements. As a consequence, the information presented here on timber supply, log use, and pulpwood sources must be based in part on assumptions and estimates.

AVAILABILITY OF LIVE SAWTIMBER

Live sawtimber, which includes all growing trees over 11 in. in diameter at breast height, is the region's primary wood supply. Sawtimber provides the bulk of logs for industry use; log use, in turn, determines the type and volume of logging and manufacturing residues available as a supplemental wood supply. Availability of live sawtimber in Oregon and Washington, presented in Table I, therefore, is basic to a discussion of wood supplies, especially when considered together with data on log use, shown in Table II. The most obvious fact about sawtimber supply is that Douglas-fir and ponderosa pine make up two thirds of the total. By comparison, the more desirable species for pulp, such as hemlock, true firs, spruce, and hardwoods make up only about 30% of the supply.

MAJOR USE OF SAWTIMBER BY SPECIES

In 1957, lumber producers used 71% of the live sawtimber cut, plywood producers 15%, and pulp producers 14% (Table II). Lumber and plywood plants, which are almost completely dependent on live sawtimber, use the bulk of Douglas-fir and ponderosa pine, and, in addition, require only about one-half of the hemlock, true firs, and spruce. The pulp industry has one competitive advantage in that it can use residues as well as logs. However, since Douglas-fir accounts for 62% of the sawtimber cut, and an even larger share of residue developed in manufacturing lumber and plywood, this species must play a key role in expansion of Northwest pulp production.

Potential increases in the availability of so-called minor species are difficult to estimate because regional figures on log use are not sufficiently detailed. It is shown in Table II that the true firs account for 10% of sawtimber supply but only 5% of current log use. Thus, their rate of use may expand somewhat. The tabulated data indicate that supply and use of hardwoods are about in balance but available hardwood timber volume shown in Table I is not as reliable a figure as are the softwood volumes. Indications are that the hardwood volume shown should be doublet at least.

CLASSIFICATION OF WOOD SOURCES FOR THE PULP INDUSTRY

For 1956, the Washington State Institute of Forest Products made a detailed classification of pulpwood sources in that State* and Table III summarizes the findings. Although Washington's pulp industry obtained 34% of its wood requirements from manufacturing residue, predominantly Douglas-fir, and another 9% as salvage material from cutover lands or dead and dying trees, it did rely on logs and cordwood from live timber for more than half its raw material.

An estimate of the combined pulpwood sources in Oregon and Washington for 1957 is shown in Table IV. Total use of each class of material is that reported by the Northwest Pulp and Paper Association. The breakdown by species is

JOHN B. GRANTHAM, Chief, Forest Utilization Research, Pacific Northwest Forest and Range Experiment Station, Portland, Ore.

* See footnote to Table III.

Table I. Net Volume of Live Sawtimber on Commercial Forest Land of Oregon and Washington, by Species, January, 1953

Species	Washington		Oregon		Total	
	Western	Eastern	Western	Eastern		%
	Million board feet					
Douglas-fir	92,000	18,000	245,000	11,000	366,000	44
Western hemlock	85,000	2,500	27,000	...	114,500	15
Ponderosa pine	...	20,000	6,000	66,000	92,000	12
True firs	36,000	6,000	22,500	9,000	73,500	10
Western red cedar	21,500	1,000	6,000	...	28,500	4
Spruces	7,000	2,000	3,000	1,000	13,000	2
Western larch	...	5,000	...	5,000	10,000	1.5
Lodgepole pine	...	1,000	...	2,500	3,500	0.5
Incense cedar	...	...	3,500	...	3,500	0.5
Hardwoods	8,000	...	9,000	...	17,000	2
Other softwoods	7,500	2,500	15,000	2,000	27,000	3.5
All species	257,000	58,000	337,000	96,500	748,500	100

Source: Pacific Northwest Forest and Range Experiment Station.
Note: Although softwood timber volumes are considered relatively accurate as a 1960 estimate, the hardwood volume of 17 billion board feet should be at least doubled.

Table II. Live Sawtimber Supply and Use in the Pacific Northwest by Species, 1957[a]

Species	Net volume available	Log use				Per cent of wood used
		Lumber	Plywood	Pulp	Total	
	Millions board feet, log scale					
Douglas-fir	366,000	5,574	1,645	200	7,419	62
Western hemlock	114,500	821	74	1,007	1,902	16
Ponderosa pine	92,000	1,234	...	...	1,234	10
True firs	73,500	380	24	220	524	5
Spruce	13,000	51	18	80	149	1
Hardwoods	17,000	40	...	150	190	2
Other species	72,500	382	23	40	445	4
All species	748,500	8,482	1,784[b]	1,697	11,963	100
Per cent of use	...	71	15	14	100	...

[a] Sources: State of Washington Department of Natural Resources "1957 Timber Harvest Report," Oregon State Board of Forestry "Timber Volume Removed 1957," species distribution from production figures of West Coast Lumbermen's Association, Western Pine Association, Douglas-Fir Plywood Association, and from Washington State Institute of Forest Products Circular No. 32, December, 1957.
[b] Total represents only 49% of wood used for pulp in 1957. The balance is from residue, salvage logs, and wood from outside of the region.

estimated by adjusting information in Table III to 1957; by predicting residue species and volumes from lumber and plywood production in the two states; and finally by tempering these estimates by experience. The so-called pulp species are obtained chiefly as logs, whereas Douglas-fir is purchased primarily as chips, and the smaller volume of hardwoods principally as cordwood.

PULPWOOD SOURCES IN OREGON AND WASHINGTON

A comparison of pulpwood use, by types, in Oregon and Washington is shown in Table V. In 1957, Washington, which used 83% of the region's total, obtained half of its $5^3/_4$ million cords of wood as logs, $^3/_8$ as residue, and $^1/_8$ as cordwood. Oregon, by comparison, relied more heavily on residue to supply its pulp industry. Reference to Table I provides one reason for differences between the two states. Douglas-fir makes up 72% of standing timber volume in Oregon as compared with 36% in Washington. Consequently, growth of Oregon's pulp industry has come with expanded production of sulfate pulp. Furthermore, major expansion in Oregon's pulp production has occurred since companies were willing to depend on manufacturing residue as raw material.

TRENDS IN RESIDUE USE FOR PULP

Historically the pulp industry of the Pacific Northwest has used sawmill residue continuously for part of its raw material supply, but large volume use developed with the expansion in pulp production since World War II. During the 1920's pulp mills on Puget Sound obtained some 40% of their wood from nearby sawmills cutting spruce and hemlock lumber. Reduction in the cut of hemlock and spruce lumber in western Washington from an average of 1400 million board feet during the 5-year period 1925 to 1929, to 230 million board feet in 1935 reduced available residues of these species to less than one-fifth of the volume previously available. Meanwhile, pulp production rose, after a low in 1932, and the pulp industry depended more heavily on logs and cordwood to supply its growing demand for wood.

Table III. Pulpwood Sources in Washington, 1956,[a] by Species and Class of Material

Species	Class of raw material					Per cent by Species
	Manufacturing residue	Cordwood	Salvage material	Logs	Total	
	Thousand cords					
Hemlock	410	122	231	1840	2603	52.8
Douglas-fir	1080	50	146	138	1414	28.6
True firs	74	15	24	262	375	7.6
Alder	...	142	...	11	153	3.1
Cottonwood	3	37	...	74	114	2.3
Spruce	12	...	40	52	104	2.1
Cedar	76	...	...	...	76	1.6
Other species	22	74	...	...	96	1.9
All species	1677	440	441	2377	4935	100
Per cent by source	34	9	9	48	100	...

[a] From Washington State Institute of Forest Products report "Wood Supply and Production of the Pulp Industry in the State of Washington," Circular No. 32, December, 1957.

Table IV. Estimated Pulpwood Sources in Pacific Northwest,[a] by Species and Class of Material, 1957

Species	Thousands of cords			Total volume	Per cent of total
	Logs	Cordwood	Residue		
Pulp species[b]	2780	450	688	3918	56
Douglas-fir	470	122	1965	2557	37
Hardwoods	85	270	...	355	5
Other species	20	...	92	112	2
All species	3355	842	2745	6942	100
Per cent of total	48	12	40	100	...

[a] Sources: Northwest Pulp and Paper Association's "Economic Survey," preceding table, and distribution of species in residues developed.
[b] Hemlock, true firs, and spruce.

Table V. Raw Material Used for Pulp Production in Oregon and Washington, 1957

Thousands of cords

Type	Oregon	Washington	Total	%
Logs	548	2807	3355	48
Cordwood	86	756	842	12
Chips	568	2177	2745	40
Totals	1202	5740	6942	100
Per cent of total	17	83	100	. .

Residues Developed in Lumber Manufacture Western Oregon, 1953

Residue	Solid volume, cu. ft.[a]	Dry weight, tons[a]
Coarse chippable	32.1	0.443
Sawdust	20.5	0.283
Shavings	15.0	0.207

[a] Per thousand board feet of lumber.

Table VI. Pulp Production and Wood Consumption, PNW, 1925–58

Year	Production, thousands of tons	Consumption,[a] thousands of cords — Total	Residues	Logs and bolts
1925	323	450	180	270
1926	378	539	240	. . .
1927	469	713	300	. . .
1928	563	960	350	610
1929	780	1297	480	817
1930	815	1351	. . .	. . .
1931	818	1346	. . .	. . .
1932	608	954	300	654
1933	773	1337	. . .	. . .
1934	949	1526	350	1176
1935	1038	1694	. . .	. . .
1936	1198	1933	220	1713
1937	1523	2681	. . .	. . .
1938	1088	1792	. . .	. .
1939	1378	2384	. . .	. .
1940	1839	3069	. . .	
1941	1994	3286	. .	. .
1942	1994	2972	. . .	. .
1943	1559	2271	. . .	. . .
1944	1668	2482	180	2302
1945	1638	2462	. . .	. .
1946	1739	2768	. . .	. . .
1947	2005	3171	290	2881
1948	2116	3344	. . .	. . .
1949	. . .	. . .	. . .	.
1950	2518	3572[b]	. . .	. . .
1951	2769	4240[b]	782	3458
1952	2684	4250[b]	990	3260
1953	2808	4442	. . .	. . .
1954	3065	5150	. .	. .
1955	3413	6160	. . .	. . .
1956	3611	5921	2164	3757
1957	3690	6943	2746	4197
1958	3497	5736	2718	3018

[a] Estimated breakdown of total consumption is incomplete—based on limited information.
[b] Pacific Coast total less 250,000 cords as an estimate of California consumption.

However, such facts as the virtual disappearance of an open log market in the 1940's, and increased stumpage costs led to new interest in residue use. Since World War II growing pulpwood requirements have been largely supplied by increased use of chips from residue. Between 1947 and 1957, when pulp production increased by 1,695,000 tons per year, use of residue increased by 2, 456,000 cords, and use of logs by 1,316,000 cords. Thus, residues supplied the wood needed for about two thirds of the expanded pulp production.

PULP PRODUCTION AND PULPWOOD CONSUMPTION

Growth of the Pacific Northwest's pulp industry and its accompanying demand for wood is shown in Table VI. It was anticipated that the rates of wood consumption to pulp production might be traced to reveal an overall change in pulp yield per cord as influenced by changes in wood species (to more dense Douglas-fir) and increased production of higher yield pulps. However, it is apparent that differences in methods of reporting wood use and pulp production over a period of 35 years obscure any such effect. It also appears that some of the pulp chip supply was not included in the reported wood consumption during the period 1947 to 1955.

SOURCES OF ADDITIONAL PULPWOOD

Since indications point to a continuing rise in the region's pulp production, some further estimates of available wood supplies are included. Except for sawlogs, which provided 40% of the industry's 1957 wood requirements, there is opportunity for greatly expanding pulpwood sources in the Pacific Northwest. Potential pulpwood supplies availale as manufacturing residues, logging residues, or thinnings are estimated in Table VII. To support these admittedly rough estimates of potential supply, the basis for estimating volumes of each type of material is discussed briefly.

Manufacturing Residues

Residues developed in lumber and plywood manufacture can be estimated with fair accuracy on the basis of past surveys. Conversion factors developed by the Oregon Forest Research Center and Pacific Northwest Forest and Range Experiment Station are considered suitable, if slightly conservative, and are given here.

Table VIII. Estimated Wood Supplies, Other Than Logs, Available and Used in the Pacific Northwest, 1957

Thousand cords

Type of material	Oregon — Available	Oregon — Used	Washington — Available	Washington — Used
Manufacturing residue[a]				
Chippable[b]	3684	568	1539	2177
Other				
Veneer cores	166	. . .	66	. . .
Sawdust	1997	. . .	856	. . .
Shavings	1334	. . .	557	. . .
Logging residue[c]	1225	50	330	300
Annual mortality[d] (recoverable in thinning or salvage cutting)	4350	50	3150	150
Totals	12756	668	6498	2627

[a] Availability based on lumber and plywood production data for 1957 and converting factors reported by Oregon Forest Research Center. Use data from Northwest Pulp and Paper Association's "Economic Survey."
[b] Percentage figures for available chippable manufacturing residue by species are as follows:

	Oregon	Washington
Douglas-fir	77	61
Hemlock, white fir, and spruce	10	25
Ponderosa pine	9	7
Other	4	7

[c] Based on last statewide survey of logging residue in western Washington, and assuming in 1957 that recoverable residue in western Washington and western Oregon averaged 5 and 10% respectively of the timber volume removed in initial logging.
[d] Based on the rule-of-thumb that mortality averages 0.5% of timber volume each year.

Residues Developed in Plywood Manufacture Western Oregon, 1953

	Solid volume, cu. ft.[a]	Dry weight, tons[a]
Cores	3.5	0.049
Veneer clippings	9.6	0.134
Roundup, log trim, and spur trim	5.5	0.077

[a] Per thousand square feet of plywood, 3/8-in. basis.

The above factors have been used to calculate the manufacturing residues developed in the Pacific Northwest in 1957 as shown in Table VII. Species distribution is based on production figures of the lumber and plywood industries for the year.

More than 70% of the manufacturing residues developed in Washington and Oregon, and 80% of those developed on the west side are Douglas-fir. Furthermore, since it is the practice at some mills to mix log species in sawing, some of the residues from pulp species are mixed with Douglas-fir. Thus, if the $2^1/_2$ million cords of unused chippable residue, or the nearly 5 million cords of fine residue are to contribute to increased pulp production in the Pacific Northwest, it is desirable that ways be found to improve the quality of Douglas-fir pulps and especially to improve their usefulness in a wider variety of paper products.

Logging Residue

Volumes of wood available as logging residues on cutover land are difficult to estimate because of the wide variation found. The last statewide survey of cutover lands in Washington revealed that there were 7 to 23 cords per acre of usable wood left after logging. Volume estimates were based on pieces 4 ft. or longer in length and containing a minimum volume of 5 cu. ft. The material consisted primarily of tops and broken pieces.

Since it is considered that the small volumes per acre would limit salvage to the more accessible portions of cutover land, estimates of available volumes of logging residues in Table VII are taken as one half of the estimated quantities accumulated annually. Available residue was considered to average about 5 cords per acre in Washington and 10 cords per acre in Oregon, or 5% of the initial timber volume removed in Washington and 10% of that removed in Oregon. The totals arrived at are admittedly rough estimates.

Annual Mortality

A rule-of-thumb for estimating the volume of sawtimber lost through mortality in Washington and Oregon is 0.5% of timber inventory each year. Observations made on 37 permanent sample plots for a period of some 25 years revealed that losses ranged from 16 cu. ft. per acre per year in 25- to 35-year-old stands to as high as 341 cu. ft. per year in some 70- to 100-year-old stands.† On the average, the loss was 83 cu. ft. per acre per year or 1 cord per acre. If the 29 million acres of forest land in the Douglas-fir region were fully stocked with growing timber, the potential mortality loss could amount to 30 million cords. Thus, the figure of $7^1/_2$ million cords potentially recoverable each year from growing stands in Washington and Oregon appears attainable if and when this wood is needed. The best estimate of the amount of wood recovered in thinning operations in 1957 is 50 to 100 million board feet or 100,000 to 200,000 cords. So far as can be determined, only a small proportion of this timber was used by pulp mills and most of it was sawed into lumber. The important fact is that only 1 to 2% of the potentially available material was used for any purpose.

Expanding the use of manufacturing residue, including some proportion of the sawdust and shavings available, to meet future wood requirements appears more attractive economically. But, from a long-range standpoint, recovery of wood otherwise lost through mortality—by thinning and salvage cutting—deserves increased attention.

† Johnson, F. A., "Mortality Studies in Young Fir Plots Show Great Annual Wood Losses," *The Lumberman*, June, 1953.

The Sandy Hill Rotoformer

G. E. Clink

It is indeed a pleasure to be asked to come before this group to talk on the Rotoformer, especially inasmuch as a paper was given on it several years ago, and to be asked to come back again and give a repeat performance is certainly an indication of interest and a pleasure for us to do.

G. E. Clink, The Sandy Hill Iron & Brass Works, Hudson Falls, N. Y.

Vacuum forming of paper has been acclaimed in the trade papers as the "Machine of Tomorrow," and as the Rotoformer is a vacuum former, you are wondering how it fits into the future. Secondly, quite a number of installations of the Rotoformer have been made since the original paper was presented here, and you are wondering what has been accomplished on these new installations.

We will start with a physical description of the Rotoformer, and then tell some of the applications which have been made of it, and finally, list some of the characteristics which seem to be unique with the Rotoformer.

What is the Rotoformer?

It is a method of forming paper which employs some of the characteristics of both the fourdrinier and the cylinder. Like the fourdrinier, it can form a self-supporting web of paper, but occupies the approximate space of one cylinder vat. It is composed of a headbox, a wire-covered rotating cylinder in which are arranged suction boxes, and a couch or press roll. The headbox is constructed of stainless steel, and has either a Sandy Hill Bertrams flow distributor, or a simple fish tail flow spreader which brings the stock from one pipe to a uniform consistency flow the width of the machine.

Immediately after entering the headbox proper, the stock is passed through a holey roll, and a portion of the stock goes to the forming area between an apron and what we call the "pond regulator." The other portion of the stock which is not needed for the forming of the paper goes on the other side of the pond regulator to an overflow dam, where it can be collected and brought back to the original starting point, to be recirculated.

The exact form of the headbox is varied to meet the individual requirements of the mill, some of which have a basement, and some require everything to be above the machine room floor. The headbox is fitted to the cylinder so that the forming area covers about 20% of the cylinder. It is sealed on the vertical edges by spring or air loaded micarta or Teflon packing, and across the machine at about the horizontal centerline by means of a rubber lip.

The forming cylinder is a centrifugally cast bronze, or a centrifugally cast stainless steel shell, depending upon the individual requirement. This shell is drilled much similar to a suction couch and, of course, considerable study has been made of the drill pattern to obtain the best results in drainage and formation characteristics.

The shell is fitted with ductile iron rings on each end which form bearing rings, which in turn are supported by a specially designed water-lubricated bearing material. Attached to one bearing ring is a ductile iron gear, which in turn is driven by a pinion attached to the indrive shaft of the machine.

The cylinder is covered with a backing wire of either bronze or stainless steel, followed by a facing wire, the mesh of which is determined by the particular product which it is desired to make. These wires are wrapped around the cylinder tightly and welded with a seam similar to fourdrinier wires.

At each end of the shell there is a supporting frame which carries the bearing for the shell and extends up to the top of the cylinder to hold the suction boxes which are inside the cylinder, and the press roll which is located on the outside.

The cylinder is kept clean by means of a high pressure Broughton oscillating shower on the inside of the mold which goes from the inside out through the holes of the shell, and also by two showers on the outside of the mold which are placed opposing each other and actually spray-wash the surface of the wire. The cylinder is an open end cylinder and arranged on the inside of this cylinder is first, a free-fall pan which is located in the bottom and which collects the water which drains first through the cylinder and conveys it to a mixing box.

Above this free-fall pan is a combination suction box, usually in two compartments, the first compartment of which is usually submerged in the stock. As the sheet is formed and comes out of the pond of stock, a second compartment takes

over and dries the material. There may be a third and fourth box, depending upon the particular product and speed at which the machine is to be run. The couch roll, or press roll, may be located over one of these subsequent boxes and gives the effect of a suction press.

If the machine is being used similar to a fourdrinier, the sheet is then blown off the wire by means of an air jet and passed to the press felt under a fly roll. It is, however, possible to use the same machine with a felt pickup by running the pickup felt around the couch roll and taking the sheet to the presses on the felt.

The vacuum on the various suction boxes is usually supplied by one pump which is attached to a header with individual connections to the boxes. The first suction box, as a rule, handles a great quantity of water and very little air. Therefore, the outlet of this box is taken to a separator located on the back side of the machine, the bottom of which is connected to a drop leg or to a white water evacuation pump, and the top of which is connected to the vacuum header.

The second box will handle less water and more air, and inasmuch as this is quite a deep box we have found that we can use the suction box itself as a separator, connecting the bottom of it to the drop leg or white water evacuation pump, and the top part of the box to the vacuum header. The third box has been handled in several ways—sometimes with a separator on its discharge, and sometimes taking the air and water directly to the vacuum pump.

The waters collected from the free-fall pan and the first and second suction boxes are usually returned to a mixing box which is equipped with a conventional overflow, to dispose of the excess white water. The new stock is then introduced at the other end of the mixing box, and mixed with white water to feed the fan pump ahead of the machine.

The Rotoformer is driven with either an electric drive or conventional mechanical drive, whichever seems to suit the particular mill requirement best. The method of operation is that the stock is brought to the headbox, and flows to the forming area. The speed of the stock approaching the wire is controlled by the pond regulator which is adjustable in several directions so as to open up or close the area between the pond regulator and the cylinder, and hence control the velocity of the stock in the forming area. Formation and squareness may be changed by this adjustment.

The stock is formed on approximately 18 in. of the cylinder. The first drainage is natural drainage due to hydrostatic head, and is what we usually call "free-fall." This gives an open formation at the point where the drainage rate is the greatest. It then progresses to the suction box area where drainage is maintained even though the mat somewhat restricts it.

The suction boxes are so arranged that they can be moved around the periphery of the cylinder to give a greater or less free drainage area, and so vary the time at which the vacuum box takes over. The second compartment of the first box is usually set just above the pond at the edge of the lip of the pond regulator, so that when the stock comes out of the pond it is held firmly against the wire to eliminate slough and a disturbance of formation.

The question immediately arises as to how we can form in 18 in., when on fourdriniers considerably longer forming areas are used. I think that this can be explained by the recent and past research on table roll drainage, which points out that drainage is induced by the vacuum at the nip, and that this drainage area probably extends only a matter of $^1/_4$ to $^1/_2$ in.

Therefore, in considering the conventional fourdrinier table, if there are 20 table rolls in the table, it is possible that the actual forming area may be anywhere from 5 to 10 in. Inasmuch as our forming area is continuous, the forming areas are not so much different as we would expect. The suction box section on the fourdrinier, of course, is replaced by the additional suction boxes which are found on the Rotoformer.

Comparing the Rotoformer with cylinder formation, there has of course always been considerable disagreement as to what part of the cylinder did the forming. I think it is now agreed quite generally that the forming on a cylinder machine is done quite rapidly and that from there around to the place where the stock comes out of the pond, it is being brushed and disturbed by being dragged through a liquid with little additional formation, and at times disturbing or destroying an originally good formation.

In the case of the Rotoformer, the stock is introduced against the cylinder and immediately that it is formed it is withdrawn from the pond and held in its original formation state. The length of the forming area may be changed in several ways. One is by lowering the final lip on the pond regulator and thereby shortening the forming area, or by extending the apron and shortening the forming area from the other end. In this way only that part which is actually forming the sheet is used.

There is another feature of the Rotoformer—that the stock coming between the pond regulator and the cylinder can be further speeded by forcing a slight excess of stock beyond what can be formed. This then overflows the lip of the pond regulator and is collected in the pond regulator itself, and returned to the mixing box.

As I have mentioned earlier, there are several ways in which a Rotoformer may be used, and I have diagrams here which show the two basic variations. One would be really an adaptation of the fourdrinier principle, in which the sheet is formed on the forming area; dried on the suction boxes; pressed on the couch; and then is taken off and passed to a press felt. In this case the sheet must be heavy and strong enough to make the pass from the Rotoformer to the press felt, unsupported.

The other basic arrangement is that the Rotoformer be used similar to the cylinder vat with a pickup felt. The pickup felt approach is over the headbox, covers the sheet on the wire, and is finally passed under the couch. The sheet then follows the pickup felt forward to either an extractor or drum press, or is simply returned over the couch to the press section.

The Rotoformer is ideally situated to handle both of these conditions, since the dryness of the sheet approaching the press roll can be controlled by the amount of vacuum carried in the various boxes. Hence, if a pickup is used which requires that the moisture content at the couch be considerably higher than would be true on a fourdrinier couch, the sheet can be so conditioned by relieving the vacuum as to leave sufficient water in the sheet to make it marry with the pickup felt. The Rotoformer may also be used in multiples of Rotoformer units, similar to a conventional cylinder machine, as it is quite possible that in some cases a solid sheet cannot be made in sufficient thickness on one Rotoformer. You will see here a typical arrangement whereby the Rotoformers are used in multiple units.

The Rotoformer has also another big advantage in this operation because it may be that the conventional cylinder would bring up a consistency of stock to the felt which might be quite wet, and much wetter than it would need to be for the pickup. However, the basic drainage of the conventional cylinder does not easily allow this to be varied beyond what will drain by natural gravity.

The Rotoformer, on the other hand, can dry out the stock coming to the felt to just the proper amount of moisture for adhesion and pickup, and hence it is quite possible that under these conditions the Rotoformer can produce a drier sheet than could be obtained from the conventional cylinder.

We have still another arrangement which has been used on several installations, and which is said to be highly satisfactory. That is to set the Rotoformer on the end of a cylinder machine, and make on it a portion of the sheet. Then

this sheet, which must be sufficiently strong and heavy to permit its passing freely through the air unsupported, is taken to the couch of the last of the preceding cylinder vats. The Rotoformer sheet is laid on top of the sheet formed on the vats, and the two conveyed on the pickup felt to the press section.

It has previously been thought that this would not supply sufficient ply bond to make a satisfactory sheet, particularly inasmuch as the Rotoformer sheet might be 20 to 24% stock, whereas the sheet from the cylinder might be in the neighborhood of 10 to maybe 14%. However, what seems to have occurred is that the cylinder sheet brings with it a sufficient quantity of water so that even with the drier sheet being laid on top of it, the two marry at the presses sufficiently to give a satisfactory ply bond.

This operation has another advantage inasmuch as it has been possible to put the two wire sides of the sheet together and hence get away from a wire mark on the sheet. The Rotoformer seems to have another inherent advantage in that there are some sheets which can be formed on a single cylinder, but the resulting moisture content of the sheet is so high that the only way that it can be conveyed from the cylinder to the press section is on a pickup felt. This disadvantage of cylinder formation is not true of the Rotoformer, due to the control of the moisture which it apparently has. Therefore, you can make on the Rotoformer several products, for example, roofing felt, which is dried on the Rotoformer to a consistency such that it can be passed on an open draw to the press felt.

You may ask about some of the basic characteristics of the sheet formed on the Rotoformer, and this I think is also an interesting part of the Rotoformer performance. One of the things which seems to be inherently a characteristic is the levelness of the sheet which it produces. I have had a number of customers remark that the profile of the sheet formed on the Rotoformer has been excellent. We feel that this possibility is due to the action of the vacuum forming, inasmuch as the thing that determines the pickup or formation of the sheet is basically the drainage characteristics of the sheet; and hence if a sheet should tend to form in one spot heavier than in another, that spot would have a lower drainage rate than a thinner part of the sheet, but with the Rotoformer the light spot then fills in to end up with a mat of equal density, and hence equal weight.

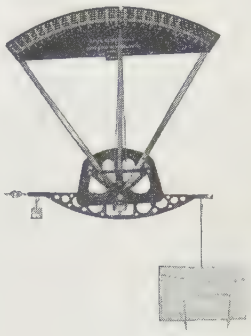
To compare this condition to a fourdrinier operation, which depends on the method of placing the fiber suspension on the wire: With the conventional slice, a certain volume of water is emitted through the slot between the slice and the apron and deposited on the wire. If this suspension does not carry exactly the same concentration of fiber at every spot across the wire there is nothing that you can do about it except that you are going to have heavy and light streaks across the sheet. It is regulated entirely by the stock which flows through the slice. The Rotoformer, on the other hand, has an ability to do something about it before it comes out of the pond, and hence we feel that it does give us the levelness which has been remarked in the trade.

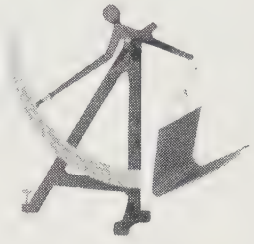
The cylinder, on the other hand, has somewhat the same drainage characteristics as the Rotoformer, except that not being able to hold the sheet firm means that some of the original formation is not maintained in its travel through the vat. Secondly, because of the softness of the sheet caused by high water content after the sheet comes out of the vat, it will sometimes slough and slide to the point where the original formation has been disturbed and destroyed.

Another characteristic which has been acclaimed by many of our customers has been the reproducibility of results; that is, after experimentation has been conducted to get the best formation on a particular sheet, and you record the various regulator settings to make that particular sheet at a certain speed, that condition then can be returned to in the future to get the same results that you had the first time.

THWING-ALBERT BASIS WEIGHT SCALES

Known the world over as Precision Basis Weight Scales. Have accuracy to meet laboratory requirements yet are rugged enough for production requirements.





Ranges from 1 gram full scale direct reading to 400 pounds ream weight. Feature anti-friction weighing. Differential models also available.

Thwing-Albert means accuracy

THWING-ALBERT INSTRUMENT COMPANY

5383 Pulaski Avenue
Philadelphia 44. USA

#168

The Rotoformer has afforded a means of controlling squareness on the wet end, and tensile ratios of 1.5:1 to 5:1 have been reported. There have been reported savings in stock preparation where the Rotoformer has been used as it seems that freer stock can be used and maintain sheet characteristics.

In the early history of the Rotoformer, it was used primarily on those grades which were free and required high dilutions and low speeds. Since that time, it has been used on much slower grades and seems to be equally adaptable to both slow and free grades. Grades and weights of paper made on the Rotoformer are numerous, and sheets as light as 10 lb. have been made successfully, as have other sheets ranging up to 400 to 500 lb. per ream.

Considerable testing has been done with forming various synthetic fibers, and the results are sufficiently good that several machines are under consideration for this purpose. The Rotoformer presently has been run at speeds up to 500 f.p.m., and there are several running in the 300 to 400 f.p.m. range. However, we do not feel that this is necessarily a speed limitation, and it may be that in the near future speeds of 1000 to 1500 f.p.m. on certain lightweight grades may be obtainable.

You may see from the foregoing why we feel that the Rotoformer has a place in the "Machine of Tomorrow."

Forest Biology Conference

New Washington Hotel, Seattle, Wash.

Aug. 24–27, 1960

PAPERS OF CURRENT INTEREST

Process Control as Related to Fourdrinier Operations

ROGER L. TRAXLER

Process control as generally practiced by the technical control departments in the paper mills of Scott Paper Co. is discussed. Particular emphasis is placed on furnish, chemical addition, and white water control. Examples of useful laboratory test results are cited. Quick and meaningful tests which can be used as control guides must be adapted to each machine and each process. When the collected process information is correlated with operating experience, process control can then be a positive force in assisting production to attain the quality objectives.

WHY BOTHER with quality control? Ridiculous question? Of course. In today's highly competitive market the slogan which was heard not too many years ago, *Quality of product is necessary for continuing success*, is certainly as true now as then. This principle was recognized by Arthur Hoyt Scott, then president of Scott Paper Co., when in 1924 he established a quality control group called Consumer's Representative. Since then, the Consumers' Representatives have worked in a very positive way to establish and maintain a uniformly high quality product. Quality control is completely separated from production at all mills, for the Chief Consumers' Representative reports to the director of product standards, who is responsible to the administrative vice-president. Through the implementation of this program, Scott Paper Co. has become a leader in quality in the sanitary tissue industry.

Having established controls on quality, it seems reasonable that a control of the papermaking process would make the achievement of uniform quality easier and more economical by minimizing rejections, lost time, and waste. This is a discussion of process control as generally practiced by the technical control departments of Scott Paper Co.. Since all Scott mills are not physically laid out and operated alike, control practices are varied to fit the circumstances.

Process Control was established to measure the materials in the process and to inform production of the trends and variations from a standard which has been established from operating experience. It would have been desirable if all control testing could have been confined to the wet end of the paper machine. However, because the process begins long before this, it was important at first to conduct tests to determine what values were necessary for standard operations in order to assure attainment of quality objectives.

Various points in the process were then selected as giving directional guidance to the operation. Originally, the work was conducted only one shift per 24 hrs. However, it shortly became apparent that the value of the work indicated the necessity for 24-hr. coverage of our three-shift operation. In January, 1945, the process control laboratory was sufficiently staffed so that continuous testing can be conducted. It must be remembered that thisis a service designed to assist operating personnel. It is not a part of the production organization, although some knowledge of the papermaking process is essential so that data can be properly analyzed.

ROGER L. TRAXLER, Process Control Engineer, Scott Paper Co., Chester, Pa.

This discussion includes more than just testing at the wet end, for as previously mentioned, the process begins considerably before this point. For convenience, our discussion will be divided into two parts, although in reality, all of the tests are so interrelated that they cannot be separated in practice.

FURNISH CONTROL

Control of basic raw materials is necessary so that the expected results can be attained at any point in the process. It then follows that specifications on pulp must be made and enforced. This principle is relatively easy to accomplish with pulps purchased from an outside source. In this case pulps which do not fall within the specified limits are unacceptable and rejected.

Pulps from within the integrated mill or shipped to the paper mill from a company-owned pulp mill must also meet rigid specifications. This can be accomplished by having a strong quality control program and by assisting production through pulp mill process control. Pulp mill process control is a separate subject. Suffice it to say that the basic principles of paper mill process control are also applicable to pulp mill process control.

Although the testing of pulp to assure meeting the specifications is not generally a direct process control responsibility, the information is nonetheless available to assist in the proper evaluation of data.

Pulp utilization and furnish control are a responsibility of the technical director in Scott-owned mills. Not only is he charged with the responsibility of pulp allocations, but the analysis and recommendation of controls of stock loss, chemical additions (including color), and white water utilization.

Control procedures are set up on these factors. Baled pulps are relatively easy to control by generally accepted practices, i.e., moisture testing, weight, and specified number of bales per furnish. Slush pulps are furnished in standard methods. However, sufficient laboratory consistency tests are run to substantiate instrumentation and to inform production if it is necessary to make adjustments for uniform quantity addition.

As previously noted, stock loss analysis and white water utilization are a part of technical control and fall under the jurisdiction of process control. Although, on the surface, this may seem far afield, the process cannot be explained or controlled unless stock loss and white water usage are regulated. Naturally, stock and white water losses have their economic implications, but the close control of these is essential to avoid variations in the process because of the possibility of uncontrolled fiber loss. At the Chester mill, two men are assigned this task. They make frequent checks of saveall efficiencies, and are charged with the analysis of all sewer losses. From results obtained by them, changes in various parts of the process are made.

Chemical additions (including color) are an integral part of the furnish. In the tissue industry, colored products have increased in volume such that process control must devote more and more attention to them. However, since these problems are unique to each mill and chemical usage and color control are such broad fields, they will not be discussed here.

Furnish control has been singled out by many as the most important factor in process control. Any errors or large variations in furnish are reflected in the entire process. With-

out sound furnish control practices, subsequent testing and analysis can become meaningless.

On each shift, tests are taken of furnish consistency, freeness, and pH. In addition, classification of fiber length is made daily. Some of this information is of immediate use to production groups (such as consistency), whereas the balance of the data can be used either to confirm that the process is under control or to detect trends in the system. If deemed necessary, certain sampling is accelerated until control is reestablished or the desired information is obtained.

As the stock approaches the stuff gate, consistency tests are taken for weight control. In addition, freeness and fractions are run after the last refiners. It has been beneficial in some cases to take periodic freeness tests throughout the entire system. This information is then available for use as the basis for getting an unbalanced system back under control.

The value of a classification, or fiber fractionation, after the last refining has been demonstrated on more than one machine. For example, when the per cent retention on the 14-mesh screen falls below a certain level when making a specified grade, the machines are generally in trouble. When the 14-mesh fraction is raised, the machines start getting well again. This was a control guide for the machines. A thorough interpretation of test data will generally highlight a guide (or guides) for each machine. These guides then should be checked first when the machine is operationally "slipping" or producing below average quality.

Throughout the entire stock system, as much information as would seem useful is gathered and recorded. One such reading is the line amperage being drawn by refiners. This is used as an indication of the relative amount of refining being done on the stock. In order for this to be useful, it is necessary that the field excitation on synchronous motors driving refiners be kept constant. Additionally, operational data on the refiner must be made available to the operating personnel. This is accomplished by taking stock samples at selected amperage readings. The stock samples are tested for freeness, breaking length, and fiber length. A refiner curve can then be made,plotting amperage against the test results. With the use of the curve, the operating personnel can determine the optimum setting for a given furnish. Periodic rechecks of these curves can often indicate a need for refiner maintenance.

ON-MACHINE TESTING

Machines are tested each shift for headbox and tray consistency, as well as those tests already mentioned. All of the information which has been gathered throughout the machine system is considered as an integral part of the machine testing so that a valid analysis of data can be made. From the headbox and tray consistencies, a water rate calculation can be made. This calculation is made to inform the operator of the volume of water coming out of the slice in gallons per minute.

If the water around the headbox and tray sections are primarily confined to the circulating system a water rate can be calculated.

S = reel speed, f.p.m.
$B.W.$ = basis weight (corrected for moisture) lb./1000 gal.
$H.B.$ = headbox consistency, lb./1000 gal.
T = tray consistency, lb./1000 gal.
W = width of slice, ft.
2880 = number of sq. ft. per ream (tissue)

$$Gal.\ per\ min. = \frac{S \times W \times B.W. \times 1000}{2880 \times (H.B. - T)}$$

This can be simplified to:

$$\frac{S \times B.W. \times C}{(H.B. - T)} = gal.\ per\ min.$$

where

$$C = \text{a constant} = \frac{W \times 1000}{2880}$$

A useful index on water rate is gal per ft. of speed. This would normally be tied to wet end speed and is obtained by dividing the water rate by the speed. This gives an easily remembered guide which is not dependent upon speed Headbox and tray consistencies also will yield a calculated per cent wire retention and a fines-to-furnish ratio. Wire retention, which is used because it is easily visualized by the Production group, is calculated as follows:

$$\frac{H.B. - T}{H.B.} \times 100 = \%\ Retention\ on\ wire$$

As previously mentioned, each machine may have its own control guide which, when detected as being out of range, will prompt more concentrated testing to help eliminate the trouble. For example, on one machine if the headbox consistency is not in the range of 38 to 42 lb. per 1000 gal., machine operation is very erratic. When headbox consistency is restored within these limits, fewer breaks are encountered on the machine. On another machine where high tensile strength was an important quality factor, analysis of the operating data revealed that when wire retention fell below 75%, tensile strength became a major problem.

Weight profiles are periodically made with a beta-ray gage. Using the recorded profile, corrections can be made at the slice to obtain uniformity across the sheet. Frequent reel moisture tests give direction to the operator when changes in moisture content are needed. These results are correlated with quality and converting needs.

It is realized that operating data on the machine are easily forgotten. Consequently much information is gathered which is not necessarily of immediate use. These data may include slice settings, headbox levels, fan pump valve settings, theoretical head, machine speed, and wire weight. As is the case in all process control, there are no specific tests which must be made, since each machine and each system is not set up identically with the next. However, regardless of how much potentially useful information is gathered, that information is meaningless unless properly interpreted. Proper interpretation is not accomplished without consulting with and correlating data with the practical experience of operating personnel. We have found that only after such correlation can test data result in real quality gains and improved machine performance.

It is the duty of those engaged in process control activities to devise supplemental testing procedures which are rapid and useful even though the tests may not be accepted as standard. Naturally, it is desirable to use standard testing, however this practice may prove to be time consuming or impractical for other reasons. As long as a test is reproducible and has a practical use in Process Control, it has value. For example, when testing pressed handsheets in the process laboratory, brightness results would be useless if the tester waited for the sheets to airdry. Infrared lamps were brought into play and after exposure for 3.5 min., the sheets are almost airdry. Although not an accepted standard test it is an excellent shortcut control method. Also, rather than running a 10-g. sample for 20 min. in a Bauer-McNett fiber classifier, for control purposes it has been found that a 5-g. sample at 10 min. is reasonably close to the standard test. These are but two methods which are shortcuts in process control, but each mill can devise its own tests depending upon the need.

SUMMARY

Process control at the wet end can be achieved only if adequate control is exercised over furnish, including pulp chemical addition, and white water. Sufficient testing must be done throughout the entire system so that the analysis of collected information can be related to the operation from the standpoint of product quality and machine performance.

Testing should be adapted to each process so that key

indices can be utilized as guideposts in the process. Data should be collected for future reference by the production personnel. All data collected must be evaluated. Consideration and thought should always be given to new tests and methods which might better and more clearly assist production in attaining the quality standards.

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Refiner Bleaching of Cold Caustic Pulp

J. F. JAHNE and C. E. PRICE

A system for bleaching cold caustic hardwood chips is described wherein the bleaching chemicals are added to the chips as they enter the primary double-disk refiner. Applying 2.5% H_2O_2 (50%), 5.0% sodium silicate, and 0.47% NaOH on an O.D. pulp basis in this way gave a brightness of 60 from an unbleached brightness of 42. This result was obtained after the chips had passed through two refiners and after the treated pulp was held a maximum of 4 hr. in a chest under the secondary refiner. Applying the same chemicals in a more conventional, batch type bleaching system gave a brightness of 58. It is concluded, therefore, that refiner type bleaching gave better results than the batch type. It is also shown to be adaptable to existing equipment and does not require addition of special mixers or bleach towers.

The pulping of hardwood by the cold caustic refiner method was started at the Diamond-National Corp. in December of 1957. The wood used is a mixture of beech, birch, and maple in about equal parts. The wood is chipped and screened to give regular $^1/_2$-in. chips.

These chips are loaded into a standard sulfite digester. After filling and closing, caustic liquor of about 10 g. sodium hydroxide per liter is pumped in and the pressure raised hydraulically to 85 lb. and held for 3 hr. At the end of this time, the pressure is taken off and the liquor pumped out. The digester with the chips still in it is then filled with water and the whole mass discharged by opening the blow line and draining into an agitated blow pit. The slurry of chips and water is pumped to a drainer conveyor and the drained chips discharged to a live bottom bin. From here the chips are fed by a system of screw conveyors to the primary refiner. The pulp discharging from the primary refiner is fed by screw conveyers to the secondary refiner and from here the pulp drops into a chest which contains a mixer to provide thorough circulation.

The pulp is about 6% consistency and 180°F. as it comes out of the secondary refiner. The refiner chest holds about 10 tons of O.D. pulp at 6% consistency. The unbleached brightness of this pulp is between 40 and 42.

When the refiner chest is full, it is pumped over to another chest. Peroxide bleach liquor is added to the pulp at the transfer pump. The pulp is allowed to stand in the second chest 3 to 4 hr. for bleaching. The temperature runs about 160 to 170°F. during this time. By applying 2.5% H_2O_2 50%, 5% sodium silicate, and 0.6% NaOH, a brightness of about 57 to 59 is obtained. At the end of the bleaching time, the pulp is pumped to a third chest which serves as a reservoir for screening. It should be noted that the bleaching is carried out on unscreened pulp. It has been found that screening and deckering reduces the pH of the pulp to about 7.0 and a separate neutralization is not necessary.

It was recognized at the beginning of this development that adding the peroxide bleach liquor to the pulp or chips before going through the refiners would be very convenient and perhaps advantageous. It was thought that the refiner would provide very good mixing of the chemicals with the pulp. The heat developed in the refiner would be fully used for bleaching and any brightness reversion due to the contract of the pulp with caustic carried over from the impregnated chips would be prevented.

J. F. Jahne, Technical Superintendent, Diamond-National Corp., Ogdensburg, N. Y., and C. E. Price, Technical Sales Representative, Becco Chemical Division, Food Machinery & Chemical Corp., Buffalo 7, N. Y.

Table I

	April 9, 1958 Point of application: Secondary	April 10, 1958 Point of application: Primary
Bleach liquor composition		
Sodium silicate, lb./gal.	2.4	1.2
NaOH, lb./gal.	0.5	...
H_2O_2 (50%), lb./gal.	1.05	0.53
Application rate, g.p.m.	1.0	2.0
Pulp rate (O.D.), lb./min.	43.0	44.5
Bleaching chemicals applied		
H_2O_2 (50%), %	2.45	2.35
Sodium silicate 41° Bé.	5.6	5.4
NaOH, %	0.47	...
Pulp tests immediately after Pumping to B1 Chest		
Temp., °F.	158	151
pH	8.2	8.0
Consistency, %	5.8	5.7
Residual H_2O_2 (50%)[a], %	22.0	30.5
Brightness	52.7	52.6
Pulp tests after 15 hr.		
Temp., °F.	142	135
pH	7.6	7.8
Consistency, %	5.8	5.7
Residual H_2O_2 (50%)	5.7	10.2
Brightness	56.7	57.8

[a] Residual H_2O_2 (50%)—expressed as per cent remaining based on the amount applied.

During Dec. 11–13, 1957, some tests were made adding the bleach liquor to the pulp as it entered the secondary refiner in one case and to the chips as they entered the primary refiner in another. The results were not very good. This was due primarily to improper equipment for adding bleach liquor, nonuniform impregnation of the chips and general inexperience in operating the refining equipment.

In April of 1958 another set of experiments were run with much more encouraging results being obtained. The results of these runs are summarized in Table I.

The bleach liquor was applied to the pulp as it entered the secondary refiner in the first experiment and to the chips as they entered the primary refiner in the second. The concentration of bleach liquor is shown for each case with the application rates and the pulp rate. From this it was calculated that 2.45% H_2O_2 50% and 5.6% silicate and 0.4% NaOH was applied to the pulp as it entered the secondary refiner. In the other experiment 2.35% H_2O_2 50% and 5.4% silicate was applied to the chips as they entered the primary refiner.

The treated pulp was collected in the chest under the secondary refiner over a period of 4 hr.. At the end of this

Table II

Temp. out of refiner.....175° to 180°F.
Consistency about.....6.5%

	Chemicals applied: H_2O_2 (50%), %	Chemicals applied: Sodium Silicate %	Chemicals applied: NaOH	After refiner: Brightness	After refiner: Residual, %	2 Hr.: Brightness	2 Hr.: Residual, %
Wood							
Old	2	5	...	45.0	30.0	48.3	16.0
New	2	5	...	55.3	49.5	60.9	23.8
Old	2	7	...	46.0	18.0	45.7	4.0
New	2	7	...	54.1	67.1	62.9	23.0
Old	3	5	...	46.7	41.0	52.0	20.0
New	3	5	...	52.5	46.5	61.8	24.4
Old	3	7	...	43.0	35.0	50.0	8.0
New	3	7	...	60.6	56.3	64.0	29.2
Old	3	5	0.2	47.3	34.0	...	...
New	3	5	0.2	55.3	49.2	...	...
Old	3	5	0.4	48.2	32.0	...	...
New	3	5	0.4	57.1	30.9	...	...
Old	Unbleached	...	...	38.6	...	...	...
New	Unbleached	...	...	39.7	...	...	...

[a] Residual H_2O_2 (50%)—expressed as per cent remaining based on the amount applied.

Table III

Per cent Chemical Applied
3% H_2O_2 (50%)
9% Sodium silicate, 41° Bé.
1% NaOH
Temp. out of refiner.....175 to 180°F.
Consistency.....7.5 to 8.0%

Position→		After refiner		2 Hr. at 180°F.	
Peroxide	Alkali	Brightness	Residual, [a] %	Brightness %	Residual, [a] %
Primary	Primary	57.1	28.5	60.5	13.0
Primary	Secondary	52.1	48.3	60.0	17.5
Secondary	Primary	47.8	46.7	58.9	21.0
Primary	None	44.5	48.0	50.0	45.9
Control	...	40.1	...	...	...

[a] Residual H_2O_2 (50%)—expressed as per cent remaining based on the amount supplied.

time the experiment was stopped and the treated pulp pumped over to the second chest. The pulp was tested immediately and results shown. At this time, the cold caustic mill was operating only one shift per day so the treated pulp was held in the bleaching chest for 15 hr. which was considerably longer than practical for continuous operation.

From this it was concluded that the idea of refiner bleaching was sound and that results at least equivalent to batch type low consistency bleaching were obtainable.

In the meantime, various improvements were made in the peroxide feeding equipment and in the chip handling equipment which made experimentation easier. Also, in the interval the cold caustic mill went to 24-hr. operation. An extended series of experiments were then made to determine the proper ratio of peroxide, silicate, and caustic necessary in this type of bleaching. A dilute solution of hydrogen peroxide was prepared at known strength and applied at a predetermined rate to the primary refiner. A separate dilute solution of sodium silicate and caustic was also prepared at and applied to the primary refiner. In this way, several different ratios of the chemicals could be applied by changing the flow rate in one or the other.

After operation under a certain set of conditions for about 15 min. several samples of treated pulp were collected as it discharged from the secondary refiner. These were all mixed together to form a composite, which was tested immediately for brightness and residual peroxide. Part of the composite was placed in a jar and held in a laboratory water bath at 180°F. for several hours with periodic tests being made. Generally, it was shown that about 2 hr. retention time was necessary to achieve maximum brightness. It was also found that extra free caustic was necessary to achieve maximum brightness. However, this type of experimentation proved to be undesirable. It appeared that the variation in brightness results was five to six points in these spot checks while running the same bleach formula. It was concluded that this was due to fluctuations in the rate of chip feed to the primary refiner. Therefore, this technique was abandoned.

Before leaving this it is interesting to note a comparison of bleaching results between new wood and old wood. By old wood we mean that which was stored in the yard more than 12 months, and by new wood we mean that which was stored in the yard less than 3 months. The results of this work are shown in Table II.

It can be seen here that treating pulp with the same chemicals gave ten points higher brightness when new wood was being used. It is also significant that the unbleached brightness of either old or new wood is almost the same. The difference is apparently in the response of the new and old wood to bleaching.

As explained above, the peroxide solution was added as a separate stream from the silicate-caustic mixture although they were both introduced into the throat of the refiner at the same place. The question came up as to what would happen if the peroxide was added alone at the primary and the silicate-caustic at the secondary and visa-versa. This was tried with rather interesting results as shown in Table III.

It is concluded from this that adding all the chemicals together at the primary gives the best immediate results and this is probably the best system to use. It is interesting that adding peroxide alone gives hardly any bleach even though the pulp slurry has a pH of about 9.5 due to the alkali carried over from the impregnation stage even though the peroxide residual persisted.

In the next phase of the work, reported in Table IV, the procedure used was like that used at the start of this development and reported in Table I. These last few experiments consisted of full-scale 4-hr. runs on one bleach formula each. The peroxide-alkali liquors were prepared and pumped separately to the primary refiner. The treated pulp was collected in the refiner chest for a period of 4 hr. with intermediate samples taken from the pulp in the chest which was under constant agitation. Tests on these samples are shown.

At the end of the 4-hr. period the pulp was pumped over to the bleaching chest and tested immediately. Tests were also made after holding this pulp $2^1/_2$ hr. in the bleach chest. It should be noted that there was no detrimental effect on brightness even though some pulp in the chest had no retention time after treating while some other had a maximum 4-hr. retention time.

From Table IV, run no. 2, it will be noted that applying 2.5% H_2O_2 50% etc. gave 60 brightness with a good strong peroxide residual at the time of pump over. Bleaching this

Table IV

	Run no. 1		2		3		4	
Chemicals applied								
H_2O_2 (50%), %	3.0		3.0		2.5		2.0	
Sodium silicate, %	9.0		5.0		5.0		5.0	
NaOH, %	0.75		0.47		0.47		0.47	
	Brightness	Residual, [a] %	Brightness	Residual, [a] %	Brightness	Residual, [a] %	Brightness	Residual, [a] %
Intermediate tests from refiner chest								
1 hr.	...	...	63.8	35.7	60.0	18.6	...	...
$1^3/_4$ hr.	58.5	10.2	62.0	34.1	...	...	54.1	15.5
$2^1/_2$ hr.	60.0	10.7	62.9	30.6	60.3	21.6	55.3	14.4
$3^1/_4$ hr.	60.0	9.4	...	...	60.0	20.3	55.9	13.8
$3^3/_4$ hr.	60.6	9.1	61.5	24.5	60.5	18.6	56.4	13.9
Test after pump over to bleaching Chest	60.0	7.9	61.5	24.5	59.9	21.8	56.4	12.4
Test after $2^1/_2$ hr. in bleaching chest	61.5	3.2	64.9	21.6	...	...	...	...
Unbleached	42.0	...	42.0	...	42.0	...	42.0	...

[a] Residual H_2O_2 (50%)—expressed as per cent remaining based on the amount applied.

same wood by the batch system with the same chemicals gave about 58 brightness at the conclusion of the retention time. As stated before, the unbleached brightness was between 40 and 42.

From this work it is concluded that continuous refiner bleaching is practical. The brightness obtained is better batch type low density bleaching. Full use is made of the heat developed during refining. The refiners also provide very intimate mixing of chemicals with the pulp.

Finally the process is simple. It is adaptable to existing equipment without addition of chemical and steam mixers or the construction of special bleach towers.

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

A Review of Corrosion Problems in Neutral Sulfite Semichemical Pulping

E. K. SCHOLZ and L. H. PARK

The erosion-corrosion problems of neutral sulfite semichemical pulping are different from kraft, acid sulfite, or cold soda. Digesting is done in one of three ways—rotary, stationary, or continuous digesters. Defibering is done before and after blow tanks by single-disk, double-disk, or combination refiner-washer. Washing is done by drum washers, screw press, or combination refiner-washer. Different type pumps are used, depending on mill experience. In the final analysis, "metal-losing" control depends upon the choice of construction materials, not only from the standpoint of chemical attack, but combinations of corrosion and erosion. In the latter case, it has been sometimes found that these are complementary; one type of corrosion would not be found if erosion were not present. Experiences of two pulp mills are used as a basis of discussion.

There is little in the literature which deals with the specific problem of corrosion of neutral sulfite semichemical equipment. Huseby and Scheil have presented a general discussion of types of corrosion (*1*), and Kesler reported the findings of work on the corrosivity of neutral sulfite cooking liquor on mild steel (*2*). This paper will discuss the aspects of corrosion, as we use it in its broader sense of metal loss, of equipment installed for the manufacture of neutral sulfite semichemical pulp.

Actually, the problem is divided into two distinct parts: (1) corrosion, or loss of metal due to chemical attack only, and (2) corrosion-erosion, or loss of metal due to abrasive action of material plus the tendency to attack metal. In the latter case, we encounter erosion which would not have taken place if it were not for the nature of the sodium sulfite cooking liquor, and we find corrosion which would not have taken place if there had not been an abrasive action of the pulp. This is because physical abrasion tends to remove the protective films which the usual highly corrosion-resistant materials have, thereby reducing their resistance.

To discuss this objectively, let us make a brief outline of the neutral sulfite process. This outline will be a basic one, and may be used for any pulping process, at any location. We will use this rough outline as a guide in discussing the neutral sulfite semichemical process and the problems of corrosion.

WOOD AND CHIP HANDLING

Since most neutral sulfite pulping is of hardwood, the wood and chip handling corrosion problems are of that nature. Design of conveyors, chutes, elevators, belts, etc., follow the conventional pattern, and there is nothing in the neutral sulfite process which would necessitate any arrangement different than existing kraft pulping layouts.

E. K. Scholz, West Virginia Pulp and Paper Co., Covington, Va., and L. H. Park, Union Bag-Camp, Savannah, Ga.

DIGESTERS

Let it be said at the start, that the severity of corrosion-erosion in neutral sulfite semichemical systems will depend on the pH of the process.

It is well known that the brightness of sulfite pulp increases as the final pH goes down, so for product reasons, a low pH, say 6.5 to 7.5 is very desirable. However, the corrosion problems increase rapidly at that low point. Most operations are carried out at a final pH of 7.5 to 8.0

In general, the industry uses three different types of cooking equipment, and these have distinct corrosion problems.

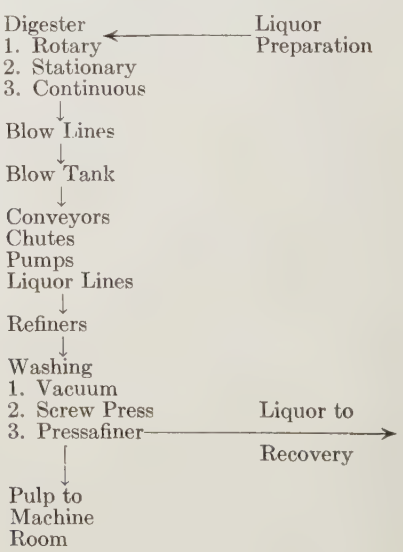
Rotary or Tumbling Digesters

This type of equipment may be spherical or cylindrical. In either case, the problems of corrosion and/or erosion arise specifically where the chips and liquor enter the digester, and where the chip mass is blown out, and in general, a slower wear throughout the entire digester. As the chips are cooked in this type of equipment, the tumbling action keeps all internal parts of the digesters equally washed, and the vapor zone corrosion phenomenon is not so apparent as in other cooking types. So, then, the largest single problem in rotary digesters is the providing of an internal surface which can withstand the erosive action of chips and liquor, and the corrosive action of sodium sulfite, sodium carbonate, and the acidic products of hydrolysis. Stainless steel spray metallizing, stainless steel welding overlay, and stainless steel cladding are in use today for this purpose.

Stationary Digesters

Here the corrosion problem is slightly modified. The erosive action of chips and liquor must be considered here also, and chutes and liquor pipes must be designed to reduce impingement to a minimum. This applies to flows of circulating liquors as well. However, the area which gives most concern is the vapor zone where the boiling liquor, with some chips, continues to wash the sides of the container and prevent any protective scale from forming. This is a severe type of attack, and durable protection must be provided, because carbon steel is not sufficient for this purpose. Many mills which formerly made acid sulfite full chemical pulp find that they have no digester corrosion problem. The brick lining commonly in use is excellent protection for sodium sulfite.

General Flow Diagram of Neutral Sulfite Semichemical Pulping Process



Continuous Digesters

There are several types of continuous digesters in operation these days. All of them have some common corrosion problems, although they are not necessarily peculiar to the neutral sulfite process.

All the feeding mechanisms of continuous digesters are designed to put chips from atmospheric pressure into the cooking pressure. Rotary valves have moving parts at close clearances to hold in the steam. The metals here are subjected to: (1) severe erosion from grit and steam flow, and (2) thermal shock going from the cooking pressure to atmospheric in some parts. This means that surface-hardened materials are needed, which will withstand the attack of sodium sulfite and organic acids, and the erosive conditions of grit and chips. Screw feeds are subjected to severe erosion on the flights as well as attack by the organic acids squeezed out of the chips. The housings of both rotary valves and screw feeds must be made of hardened material for this severe service.

The reaction chambers of continuous digesters contain screws which move the chips and liquor along during the cooking time. We find here that the metal loss along the pulp path from the feed end to the discharge end is inversely related to the pH. Here also, design and fabrication are important because moving parts set up stresses, they work-harden unless properly annealed, and these things increase the likelihood of corrosive attack.

From the digesters, the chips are dumped or blown into a bin, or, in the case of continuous cookers, they pass out through some device which allows the pulp to pass, but holds steam pressure in the digester. This latter may be a rotary feeder, or one of the special outlet valves designed for this purpose. At this point, there is flashing steam, coarse, rough pulp and/or chips, and black liquor to be handled. If the mass is merely dumped, there are obvious impingement problems in the blow pit. In most of the cases, the chips or pulp are handled through blow lines, and here, corrosion-erosion gives many problems. The velocity must be high for carrying pulp, chips, and liquor, and long radius ells used to prevent choke-ups. Here is a perfect example of the relation between corrosion and erosion. One mill experiences no loss of metal in straight sections of mild steel blow lines, but has had to go to stainless steel for bends. Even these are eroding and will have shorter life than mild steel straight runs.

In the blow tank, corrosion problems are a little more complex. One mill, running a pH of 6.7 to 7.0 from stationary digesters, has experienced a blow tank and exhaust stack life of 6 years. Another mill, running a pH of 7.5 to 8.0 from continuous digesters, has experienced no serious corrosion rate in over 8 years. Two things are apparent, but not certain. First, is that small difference in pH at that level so significant corrosionwise, and second, is it important that air is drawn back into a blow tank between blows from stationary digesters, whereas, in continuous cooking there is little air or oxygen, except during the very infrequent shutdowns? The corrosion that does occur, whatever the rate, seems to be in the upper parts of the blow tank where condensate may be concentrated, and washing of the tank sides occurs. This is true of tanks blown into, or dump tanks, or live-bottom bins.

REFINERS OR DEBIERING EQUIPMENT

In defibering equipment, the ultimate in severity of the corrosion-erosion problem is reached.

Not only are we confronted with the effect of hot sulfite under terrific pressure when the chip particles are torn apart, but the grit, sand, and tramp metal takes its toll of the plates. Even ordinary stainless steels are out of the question here. Standard practice is to use special hard alloys which each refiner manufacturer has available, and has developed for the particular characteristics of his equipment.

WASHING

There are three main types of equipment used to remove black liquor solids from neutral sulfite semichemical pulps. They are: (1) vacuum washers, (2) screw presses, and (3) combination press washing and defibering.

Vacuum washers, whether of the valveless or barometric leg type, consist of fairly intricate pipe or channel work to handle the filtrate from the vat to the filtrate tank. Some mills have had good washer drum life of carbon steel, but at least two mills have had to either replace or make extensive repairs to the first stage drums. The most serious corrosion occurs in the welds of the channels and the end rings. Not too much difficulty has been experienced with the drum sides. The vats corrode most at the liquid-air interface; however, the weak liquor for wash water usually purges the washer vat ends, and they stay in good shape. The shaft of the drum is submerged, and not too much trouble is experienced here. Experiences with the corrosion of the vacuum washer valve and drop leg are varied. One mill has run for some years with carbon steel, and at least two mills have changed to stainless steel valves and droplegs after only 2 years service.

In screw press installations and the combination press washing and defibering equipment, pressure and erosion are so severe, that nothing but stainless steel or special alloys can be considered. Screw press flights, housing, and shaft experience rapid wear when made of any but hard-faced metals, and accurate programs of determining the corrosion-erosion rate are in order to prevent too far a loss in efficiency before overhauls are made. In the combination press washing and defibering, the same conditions prevail, and here also the importance of close clearance is great enough to dictate materials of construction which will give quite long life.

The pump for sending the black liquor to the recovery system need only be cast iron or steel, but with stainless steel sleeves, where there is wear, and stainless steel impeller.

LIQUOR PREPARATION

Neutral sulfite semichemical white liquor consists of sodium sulfite and sodium carbonate, in a rough ratio of 3:1, at a total concentration of about 100 g.p.l., expressed as Na_2O. This solution may be either made up by dissolving the required amount of each chemical in water, or by sulfiting a solution of sodium carbonate. This latter solution of sodium carbonate may be either from dissolving solid carbonate, or may be kraft green liquor.

The handling of powdered sodium carbonate does not present much of a corrosion problem. The vapors from the liquid dissolving the solid carbonate cause ordinary metal rusting around the chute. The handling of the dissolved carbonate is also not much of a problem. However, when sulfur is burned and brought into contact with water, even water with sodium carbonate dissolved in it, there are local conditions of high acidity which can be detrimental to ordinary metals of construction. In this area, lead linings, ceramic tile, terra cotta, and special alloys are the answers. In recent years some of the modern temperature resisting plastics have found an application here. Normally, the absorption tower for sulfiting is of stainless steel and the draft fan is of special corrosion resistant materials. In almost every plant, the draft fan has created problems. It would seem that by the time the gases pass through the absorption tower, they should be completely free of SO_2, but this is not always the case. The carbonate pump will fail, the control valve will close, and although it is only a temporary condition, wet SO_2 will pass out the absorption tower, through the fan, and out the vent stack. It takes only a few of these episodes to give a real corrosion problem. Rubber lining, stainless steel, and even Carpenter 20 have been used. The high draft needed for this application rules out for the present, at least, some of the obvious resistant plastics, because of the speeds involved. The pipelines for "pink liquor," and the

pumps for handling same from storage, are all of steel, there being no corrosion problem here.

If raw sulfur is purchased, melted, and burned, there are only mild corrosion problems because sulfur itself, molten or solid, is fairly inert to ordinary materials of construction. Sulfur becoming wet from open storage is more corrosive, when melted, than dry. The use of green liquor to be sulfited imposes no serious corrosion problems.

DESIGN AND FABRICATION

In the final analysis of all the facts of the corrosion-erosion problem of neutral sulfite semichemical pulping, we come to one bitter truth of the experience in the industry. Even though the proper steels have been recommended and ordered, even though the design of the equipment has no fault, there is still an open field of action for a fabricator of stainless steel to work in. Unless particular follow-up is made, disastrous results may follow. The metallurgy of stainless steel is a delicate one; the theory behind the fact of the corrosion resisting properties of stainless steel is close to miraculous; yet we have suffered much in our industry simply because we gave work to a fabricator without regard to his knowledge of the art of handling stainless steels. There are countless instances of corrosion enhanced by carbide precipitation, stress, improper annealing or no annealing, and all these types of failures are the responsibility of the fabricator. Yet the metal itself or the corrosive conditions have been blamed. It behooves us, not only in NSSC pulping equipment, but all instances of stainless steel fabrication to: (1) know our fabricator, (2) be sure he understands the technology of stainless steels, and (3) in applications where highly corrosive materials are to be handled, insist on a certification of, or at least a check upon, the analysis of the particular melt from which the stainless steel was made.

LITERATURE CITED

1. Huseby, R. A. and Scheil, M. A., *Tappi* 33, No. 3: 138–148 (March, 1950).
2. Kesler, R. B., *Tappi* 41, No. 3: 102–109 (March, 1958).

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

A Proposed Test for Abrasiveness of Pigments and Paper Fillers

R. D. FRAIK and F. C. SCHMUTZ

Wear of paper producing and converting equipment is receiving greater attention because of its economic importance. A significant factor related to wear of fourdrinier wires, printing plates, and trimmer blades is that of abrasion associated with paper loading materials. Previous approaches to this problem have been for specific applications and a procedure capable of broad application in relating mill experience is needed. This paper proposes a method which may have such broad application. Data are presented covering six typical materials. In addition, some study of test variables is covered including the effect of alum. While further refinement and standardization is needed, the procedure has been useful.

Wear of paper producing and converting equipment has always been a serious problem. Because of high manufacturing and equipment costs, factors contributing to equipment wear are attaining a greater importance. One such factor is that of pigment and filler abrasiveness. Previous attempts to measure this property have been limited to specific applications. It is believed a clarification of the situation is needed as well as a procedure capable of broad application related to mill experience.

The present paper suggests a new approach to an abrasion test which appears to meet the objections of former procedures. This development is not considered complete, but the results to date are sufficiently interesting to warrant publication with hope that the procedure or a modification thereof may help in the solution of troublesome wear problems.

R. D. Fraik and F. C. Schmutz, Research Department, The New Jersey Zinc Co. (of Pa.), Palmerton, Pa.

PAST WORK

Engle, Bownes, and Dunn (*1*) describe a method for comparing abrasiveness of inks and discuss the effect that pigments and extenders used in the ink have on plate life. Degree of ink abrasion is determined in this method by comparing light transmittance through a chromium mirror before and after rubbing with a felt-covered mechanical finger in the presence of the ink. The authors claim good reproducibility but usefulness is limited to predicting plate life associated with ink abrasiveness.

The Valley abrasion tester as described by Albert (*2*) is based on the weight loss of a strip of fourdrinier wire after

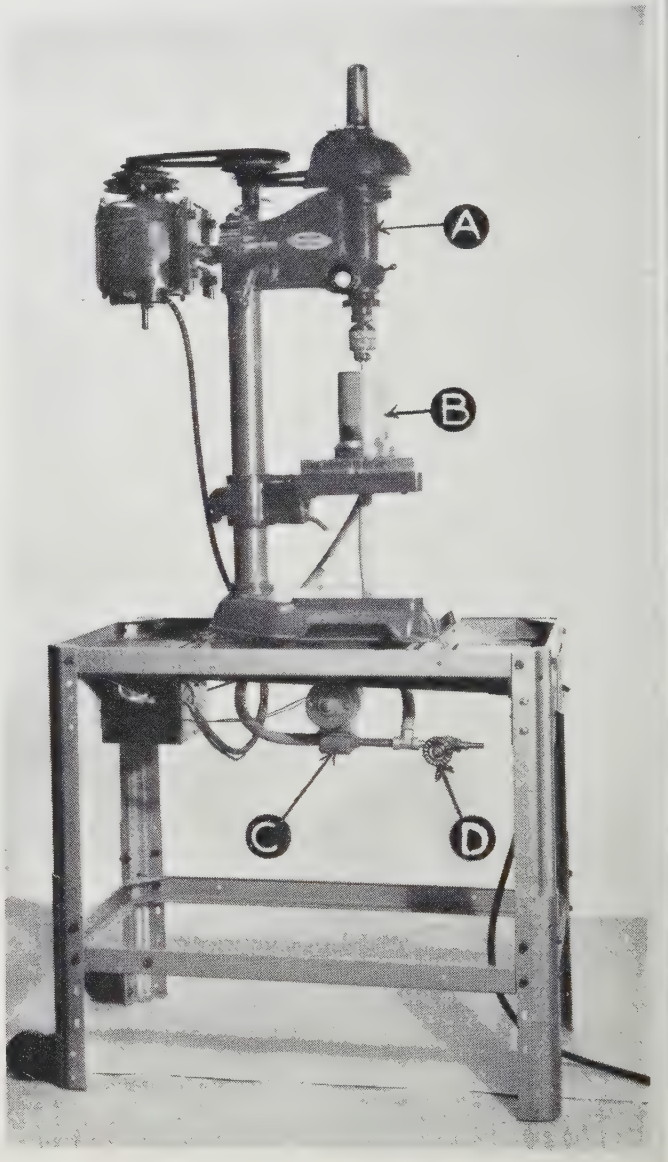


Fig. 1. Assembled apparatus

(A) Drill press used to rotate the abrasion block. Equipped with a speed-reducing pulley; the spindle turns 205 r.p.m. The spindle return spring is removed permitting the spindle to fall freely. The weight of the spindle produces the thrust. (B) Assembled abrasion cell (C) Recirculating pump. (D) Drain valve.

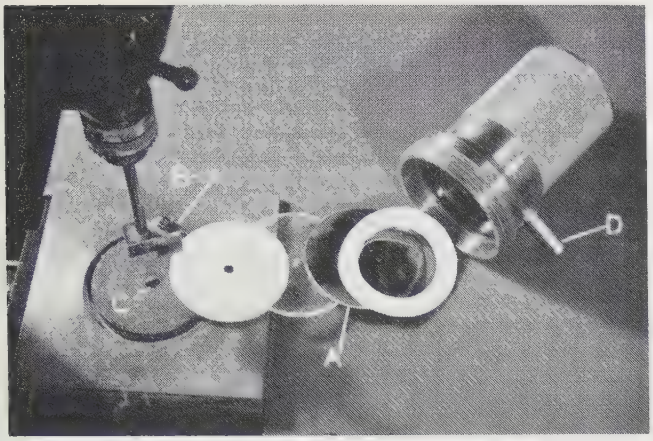


Fig. 2. Abrasion cell parts

(A) Test specimen. (B) Abrading block. (C) Slurry inlet. (D) Slurry take-off.

having been rubbed for a prescribed time with a weighted rubber block in the presence of a water slurry of the filler. This method is presented as being useful for predicting the wear on trimmer knives and printing plates used to process the filled paper as well as fourdrinier wire wear. One deficiency recognized in this instrument by Albert is that abrasion due to grit particles may affect the result disproportionate to their presence due to lack of agitation in the slurry reservoir. Thus, there is an indicated need for modification of this equipment.

DESCRIPTION OF APPARATUS

Wear associated with paper producing and converting equipment due to pigment and filler abrasion is encountered with a variety of metals under various conditions. Therefore, any test method must be sufficiently broad in scope to permit the use of different metals and test conditions. In addition, a useful test should correlate with end-use performance trends already known. The following test is based upon these objectives.

The principle upon which the apparatus and procedure are based is that of determining the weight loss of a metal specimen resulting from a mechanical action under prescribed conditions. Abrasion is accomplished by rotating a felt-covered block under thrust on a metal specimen in the presence of a pigment or filler slurry. Segragation of particles in the slurry is minimized by a pump which recirculates the slurry from the side of the abrasion cell through an opening in the center of the test specimen.

The apparatus herein described is intended only to illustrate the approach used. Because any further acceptance of this procedure would require standardization of equipment, no specific details of construction or dimensions have been given.

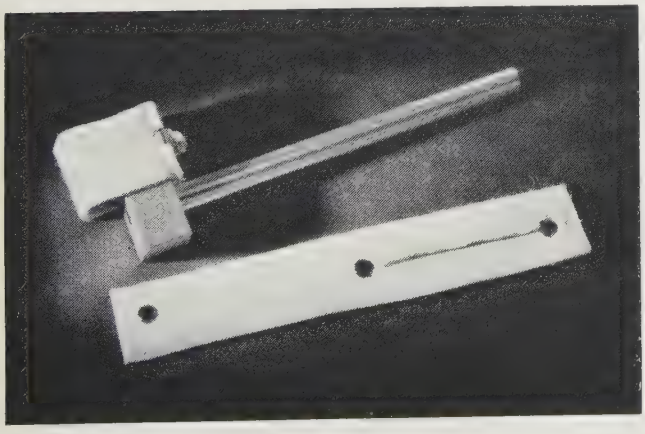


Fig. 3. Abrading block

A felt strip and the block as it appears when wrapped.

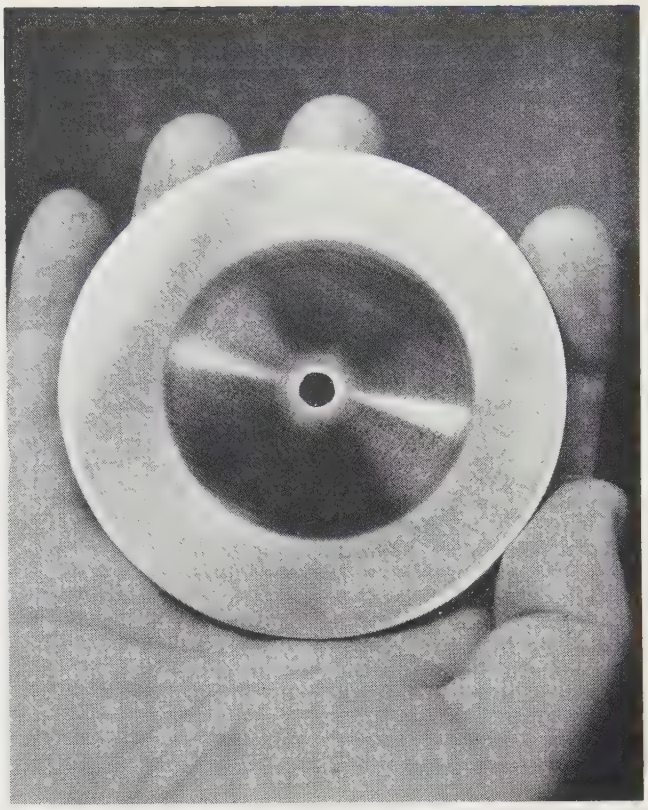


Fig. 4. Brass specimen after test

The apparatus is illustrated by Figs. 1 to 4.

As previously mentioned any test to be sufficiently broad in application must permit testing on the different metals related to paper production and processing. Of the many metals that might be considered three were chosen for the work herewith covered. They are:

1. Fully annealed brass. Similar in composition to the weft of many fourdrinier wires.
2. Copper—photoengravers plate.
3. Hardenable steel similar in composition to that used in trimmer blades.

The reservoir, its base, and the abrading block which are the main parts of the abrasion cell are machined from brass. To facilitate rubbing of the specimen by test material, the abrading block is covered with a strip of type S.A.E. F-50 white felt.

TEST PROCEDURE

Since results are relative to the wear incurred by a metal under the prescribed conditions, there is a need to maintain reference conditions of the metal specimen. Of the methods tried, variables in the metal were best eliminated by continual re-use of a specimen which was resurfaced by polishing back and forth in one direction on a wet 400A carborundum abrasive paper before each run. In addition to providing a similar surface each time, the wet polishing produces small ridges across the specimen which are subject to greater wear than a flat surface.

After being surfaced the specimen is rinsed, dried, and tare weight is determined. The various parts of the abrasion cell as indicated in Fig. 2 are then assembled and the freshly wrapped abrasion block is locked in the drill press chuck. A slurry of 35 g. of test material and 250 cc. distilled water is prepared by mixing for 3 min. in a Waring blendor.

After preliminary preparation the test procedure is as follows. The slurry is washed into the abrasion cell with an additional 100 cc. of distilled water. After the pump and drill

Table I. Abrasion Results Using a Water Slurry
Weight loss in milligrams

		Brass	*Copper*	*Steel*
Calcined clay	High	17.5	17.4	3.9
	Low	14.1	15.8	3.9
	Av.	15.9	16.7	3.9
Talc	High	6.1	6.0	1.4
	Low	4.7	4.5	0.9
	Av.	5.3	5.0	1.2
Calcium carbonate	High	4.8	2.1	0.5
	Low	2.8	1.7	0.2
	Av.	3.8	1.9	0.3
Titanium dioxide Anatase (A)	High	3.8	4.7	5.2
	Low	2.9	2.9	4.4
	Av.	3.3	3.5	4.8
Titanium dioxide Anatase (B)	High	3.6	3.4	2.7
	Low	2.3	2.2	2.1
	Av.	3.2	2.9	2.5
Clay	High	1.1	2.6	4.3
	Low	0.8	2.0	3.1
	Av.	1.0	2.2	3.8

motors are started, the spindle is carefully lowered until the felt-wrapped block contacts the specimen. The spindle is raised after 15 min. of operation. The system is drained and flushed with fresh water. The pump and drill motors are turned off and the drain valve is closed and a fresh felt is placed on the abrading block in preparation for the next run. After removal from the abrasion cell, the metal specimen is rinsed, dried, and weighed. Results are reported in weight loss to the 0.1 mg.

DATA

Using this procedure, tests were run with six fillers and pigments typical of those used by the paper industry on the metals previously discussed. The results of these runs are tabulated in Table I. The high, low, and arithmetic average reported in each case were derived from four to eight runs.

These data show that the order of abrasiveness of the materials tested is not the same when different metals are used. The hardness and other properties are suspected to account for this difference.

Subsequent printing plant and mill experience with the two different grades of anatase titanium dioxide used in this test program indicated a correlation between the results obtained with the copper specimen and letter press plate life. Similarly, the results using the steel specimen correlated with trimmer blade wear.

Since alum is usually used in stock systems where wire wear due to abrasion is a factor, an evaluation of the effect of its presence on abrasion was made. With 0.083 g. of alum added to the prepared slurries, the six materials were tested using the brass specimen. The results are given in Table II.

Although the presence of alum affected reproducibility and changed the wear values, it did not alter the order of abrasiveness of the six materials when tested on brass.

Table II. Results on Brass Using a Water Slurry Containing 0.083 Gram Alum

Calcined clay	High	13.8
	Low	5.5
	Av.	8.8
Talc	High	9.4
	Low	6.7
	Av.	7.6
Calcium carbonate	High	4.4
	Low	2.4
	Av.	3.1
Titanium dioxide Anatase (A)	High	3.0
	Low	2.1
	Av.	2.5
Titanium dioxide Anatase (B)	High	2.4
	Low	2.0
	Av.	2.2
Clay	High	1.8
	Low	0.9
	Av.	1.6

Because the difference in results of repeated runs was greater than anticipated, three test approaches were undertaken to determine the cause of variation. A calcined clay slurry five times as large as that needed for one test was prepared. With modifications in the circulating system, four tests were run on brass using this common slurry. The results obtained by this procedure are compared with values of the same material obtained by preparing separate slurries for each run in Table III.

Table III. Calcined Clay on Brass

Using separately prepared water slurries		*Using a common water slurry*	
Run no. 1	17.5	Run no. 1	11.0
" " 2	16.4	" " 2	10.0
" " 3	14.1	" "	11.3
" " 4	17.3	" " 4	9.9
" " 5	14.3		

An improvement in reproducibility was obtained by using the common slurry.

In the second approach, five runs were made using one supply of talc which had been dry-screened through a 150-mesh screen. Separate slurries with alum added were prepared in all cases. The results of this modified procedure are shown in Table IV along with those of the same material when regularly tested.

Table IV. Talc on Brass Using a Water Slurry Containing 0.083 Gram Alum Per Run

Unscreened sample		*Dry screened sample*	
Run no. 1	6.7	Run no. 1	9.1
" " 2	7.3	" " 2	8.7
" " 3	9.4	" " 3	8.7
" " 4	6.9	" " 4	8.7

Using the test material for each run from a common slurry or after screening assures better homogeneity of the samples. The results of tests using these two modifications showed better reproducibility as indicated by the data. It is believed that much of the variation in results for consecutive runs shown by the "High" and "Low" values in Table I may be associated with lack of homogeneity of the test sample.

Because there was visual evidence of incomplete dispersion of some material used when preparing by mixing for 3 min. only, 30-minute mixing of a common slurry was adopted as the third modification of procedure. The results of testing the two titanium dioxides on copper by this method as compared with tests using the same metal and the original procedure are indicated in Table V.

Table. V

		3-Min. mixing copper	*30-Min. mixing copper*
Titanium dioxide Anatase (A)	High	4.7	4.8
	Low	2.9	4.1
	Av.	3.5	4.5
Titanium dioxide Anatase (B)	High	3.4	3.5
	Low	2.2	2.8
	Av.	2.9	3.2

It is recognized that increased mixing time in slurry preparation is conducive to better dispersion of sample. Better homogeneity of slurry due to improved dispersion probably accounts for the better reproducibility. The data indicate that wear increased with better dispersion. This factor must be considered in attempting to correlate results from this procedure with mill experience. An explanation to account for

greater wear with better dispersion has not been obtained; however, this subject may be worthy of fundamental study.

CONCLUSION

Although the described test is still in a preliminary state of development, it has proved to be a very useful test to us. It should be recognized that acceptance of this procedure by others would require additional refinement and standardization apparatus and test conditions.

LITERATURE CITED

1. Engle, L. S., Bownes, K. A., and Dunn, H. J., *Paper, Film and Foil Converter* 33 No. 9. 40–41 (Sept., 1959).
2. Albert, C. G., TAPPI Monograph Series No. 19 "Paper Loading Materials," Chapter 7 "Clay," pp. 75–76 (1958).

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Equitable Allocation of Costs for Process Steam and Electric Power in Pulp and Paper Mills

GLENN D. FARRAR

This paper presents a simple method for equitably allocating operating and capital costs into the two major elements—process steam and electric power. The method is particularly well suited to economic studies for determining whether pulp and paper mills should buy or generate their own power. Two systems are compared, each of which furnishes the same electric power and the same steam to an integrated mill. One of these systems uses purchased electric power and low-pressure boilers. The other system uses high-pressure boilers and expands the steam down to the process level through steam turbines generating by-product electric power. All of the operating and capital costs of the low-pressure system are allocated to process steam costs. They are delineated but not costed in this paper. The incremental differences between the two systems are allocated to electric power, and are developed with an example showing dollar values. A heat balance for each of the systems is presented with discussion to show how incremental differences in fuel requirements are calculated. Other factors, such as incremental labor, maintenance, feed-water treatment, and incremental investment costs are included in the cost allocations.

In a large integrated pulp and paper mill today, steam and electric power costs may run in the order of $5,000,000 a year—for operation alone. It is likely that even for a new small integrated mill built today, these operating costs would get close to $1,000,000 a year. And these costs are being experienced today even with the well-developed use of by-product technology.

With annual operating costs up to $5,000,000 it is important to know what part of the cost is allocated to steam and what part to electrical power so the total cost of these utilities can be minimized.

The by-product technology that has been developed by the paper industry through the years to which I refer is these three areas: (1) steam from bark, (2) steam from black liquor, and (3) turbines topping process steam requirements.

This paper is particularly directed toward answering the question of how operating and capital costs should be equitably allocated between process steam and electric power when turbines are used.

Glenn D. Farrar, Turbine Specialist, General Electric Co., Atlanta, Ga.

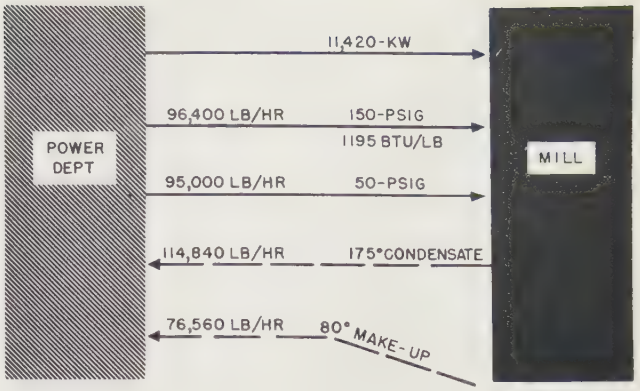


Fig. 1. Electric power, steam and water flow conditions

A simple method is presented which compares two systems. One of these systems uses low-pressure boilers which supply steam at the required process level, and purchased electric power. The other system uses high-pressure boilers and expands the steam down to the process level through steam turbines generating by-product electric power. Each of these systems is designed to furnish the mill the same electric power and the same steam flow to process at the same pressures and temperatures. Similarly, the condensate return and makeup are also the same for both. Each system is laid out with the equipment necessary for providing these identical results.

The operating and capital costs, which must be allocated to process steam when high-pressure boilers are used, are the same as these costs would be when the steam is furnished by low-pressure boilers alone. This is the basis of the method. Those items which are to be allocated to process steam will be delineated for clarity but will not be costed here. However, cost differences related to this will be presented.

The incremental increase in capital costs between the two systems will be allocated to generation of electric power. The net incremental decrease in operating costs will be credited to electric power. The items to be allocated to electric power will be developed with a hypothetical example showing dollar values. The quantities used are not intended to be directly applicable to any particular situation, but they are of reasonable magnitudes so the example can help portray the method.

The philosophy for this method is based on the condition that some purchased fuel must be used with any system, even when there is no electric power generation. This is because the total heat available from by-product fuels is not enough to supply the total steam requirements to an integrated mill. Therefore the heat from bark and black liquor is essentially a constant value, irrespective of whether power is generated. The complications of costing steam from by-product fuels can therefore be omitted in calculating power generation

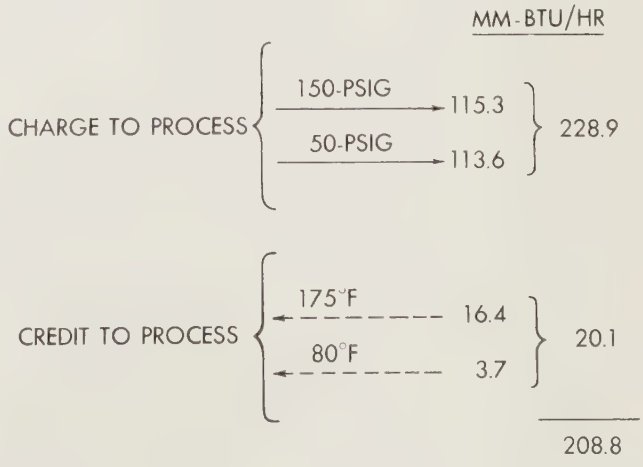


Fig. 2. Net heat to process

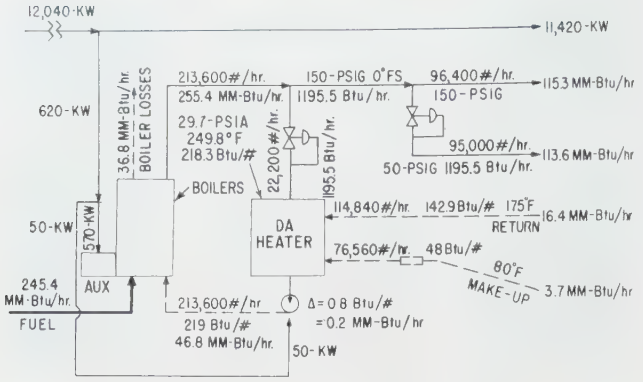


Fig. 3. Low-pressure system heat balance

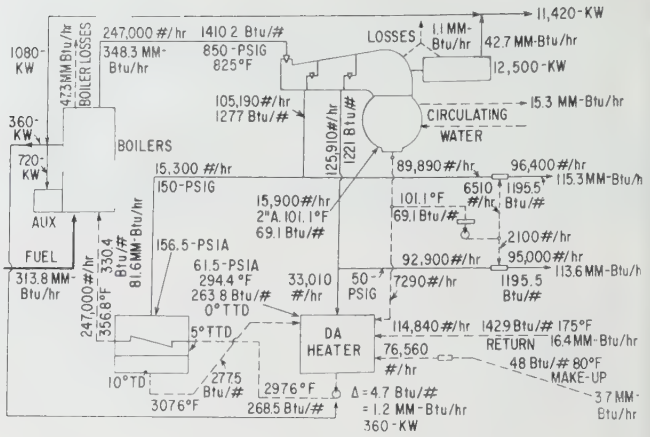


Fig. 4. High-pressure system heat balance

costs. The only fuel usage that needs to be calculated is the incremental purchase fuel required to generate electric power.

Taxes and insurance are not included in this paper. As a refinement, these small items can be added, if desired, in subsequent calculations.

METHOD

The first step in this method is to establish the electric power, steam, and water flow conditions. This is what the power department must supply to satisfy the pulp and paper mill requirements. In the example to be developed, the conditions are as shown on Fig. 1.

Throughout this method, separate nomenclature is used for the weight of steam and for the heat content of steam. The flow of steam or water is given in pounds per hour, while its heat content is given in millions of B.t.u. per hour (MM-B.t.u. per hr.).

By multiplying each flow in Fig. 1 by its heat content in B.t.u. per lb., and then dividing by 10^6, the heat flow data shown in Fig. 2 are obtained. The process is charged for heat in the steam, and credited for the heat in the condensate return and heat in the makeup. Heat in the makeup can be handled different ways. In this example it is considered that steam lost to atmosphere goes to mother Nature; therefore the department that ultimately gets charged for that loss of heat should at least get credited for the heat content mother Nature provides in the makeup water.

Now lay out two different systems, each of which is to furnish power and steam in accordance with the conditions shown in Figs. 1 and 2. One of these should be with low-pressure boilers and purchased electrical power. The other should be with high-pressure boilers and turbine-generator equipment. Each should have its required power for auxiliaries and its appropriate feed-water heating system.

The heat balances for the two systems that have been developed as examples to portray the method are shown in Fig. 3 and Fig. 4. Notice that they each furnish 11,420 kw., have the same heat to and from process at the same pressures and temperatures, have the same condensate return and the same makeup.

With this method, the low-pressure system should be designed for a steam pressure that permits minimum equipment cost. (Obviously this system would have very high operating costs.) The resulting pressure will usually be just high enough to supply the highest steam pressure required by process, or slightly above that.

In this example, pressure drops have been neglected and the 150-p.s.i.g. level is used for simplicity. The 50-p.s.i.g. requirements are obtained through a pressure-reducing valve.

As shown in Fig. 3 a deaerating heater is included to avoid putting cold water into the boilers. Whether or not this feed-water heater is used makes no difference in the total heat added to the system. The boilers of Fig. 3 supply $255.4 - 46.8 = 208.6$ MM-B.t.u. per hr. to the steam. It is assumed that the recovery, bark, and purchased fuels furnish heat as proportioned in the bar chart on the left of Fig. 5.

In the high-pressure system, all the boilers for this example furnish steam to the turbine at 850-p.s.i.g. 825°FTT. Here the steam is reduced to the required process level through turbine equipment. The power produced in this manner is the third well-known by-product in the paper mill power department.

The reason power generated in this way in a paper mill is so economical is because the process can use virtually all the heat in the steam leaving the turbine. The industrial power station thus has a marked advantage over a condensing electric utility station that has no useful heat sink that can recover the heat of vaporization. The utility must waste through its condensers alone approximately 50 to 60% of the heat from the fuel burned.

Figure 4 shows schematically the flow of heat and power for the example using a high-pressure system which generates all the electric power. As with the low-pressure system the mill is getting the same 11,420 kw. and 208.8 MM-B.t.u. per hr. net heat to process at the same pressures and temperatures.

To simplify the portrayal of the method, blowdown and many pressure drops have purposely been neglected and only one turbine-generator unit is shown. It is rated 12,500 kw. and has double-automatic-extraction at 150 and at 50 p.s.i.g. A condenser is included for economical flexibility as is so common in most mills.

Two feed-water heaters are included, which is typical for these steam conditions. Notice from Fig. 4 that much more steam is extracted from the turbine at each pressure than is sent to process. The heaters thus increase the extraction flow which permits the turbine to make more of the required power noncondensing and thus save on the fuel cost.

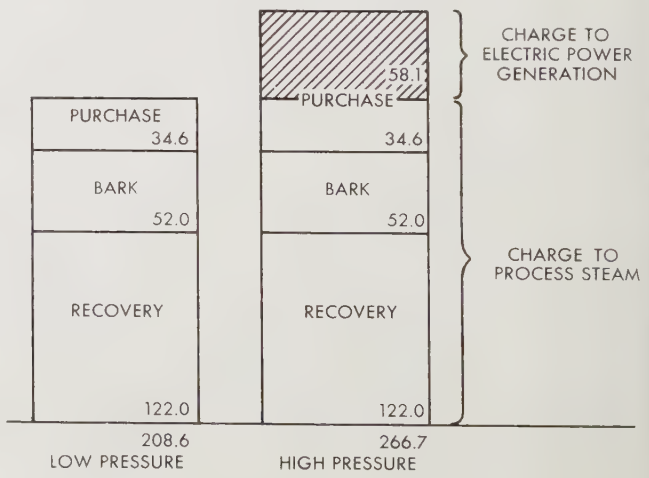


Fig. 5. Heat added by boilers, MM-B.t.u./hr.

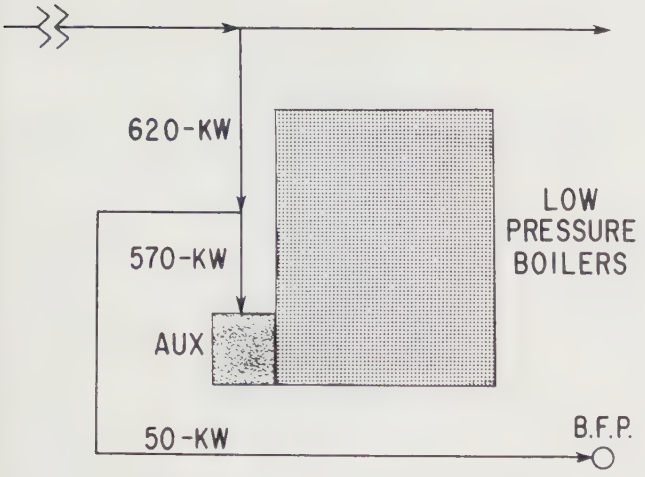


Fig. 6. All low-pressure auxiliaries (620-kw.) are charged to process steam

De-superheating stations have been included in order that the steam going to process will have not only the same pressures but also the same temperatures as in the low-pressure system.

The boilers of the high-pressure steam system shown in Fig. 4 supply 348.3 - 81.6 = 266.7 MM-B.t.u. per hr. Figure 5 shows that this is 58.1 MM-B.t.u. per hr. more than the low-pressure boilers supplied to the steam. This increment must be supplied by purchased fuel and obviously must be charged to electric power generation. The other 208.6 MM-B.t.u. per hr. put into the steam must be charged to process steam. This does not take into account low-pressure boiler losses and associated auxiliary losses, which must also be charged to process steam.

ALLOCATION OF STEAM COSTS

Figure 5 helps depict which of the operating and capital costs should be charged to process steam. From this illustration, it is seen that the total process steam cost is comprised of all the costs that are associated with the production of low-pressure steam in the required amounts, at the necessary pressures. It is important to note that all the costs of supplying low-pressure steam, as shown in the Fig. 3 system, are also applicable to steam costs with a high-pressure system.

Auxiliaries

All auxiliaries used with the low-pressure system (Fig. 3) must be charged to process steam (Fig. 6). They make no contribution to net electric power delivered. The 620kw. shown here for auxiliaries includes 50kw. for boiler-feed-pump power, and 570 kw. for all other fan, pump, and compressor auxiliary drives. These values were estimated from Figs. 7 and 8 and will be discussed more in detail later.

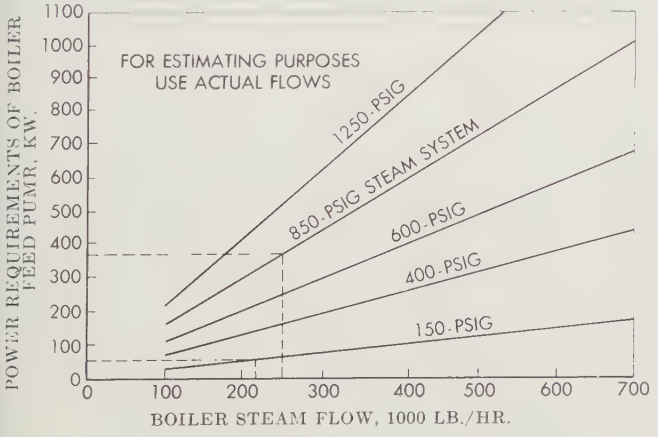


Fig. 7. Boiler feed pump relative power requirements for different plant steam conditions at rated boiler capacity

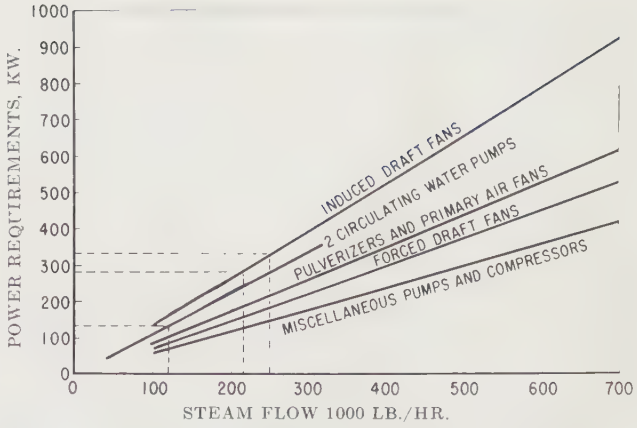


Fig. 8. Relative power requirements for all auxiliaries except boiler feed pump at rated station capacity

Although paper mills use more mechanical-drive turbines for auxiliaries than electric-motor drives, in this method all auxiliary drives are converted to equivalent kw. and then added together. This simplifies the incremental calculations, to be discussed later.

Operating Costs

The operating costs to be allocated to process steam are *all* the operating costs that apply to the low-pressure system (Fig. 3), and include the following:

All fuels burned in all the boilers.
Operating labor.
Maintenance.
Power to drive auxiliaries.
Makeup water, including treatment.

Capital Costs

The capital costs to be allocated to process steam should cover the costs of all the equipment included on Fig. 3:

Boilers, including fuel handling equipment.
Piping, including feed-water heater.
Associated land, buildings and foundations.
Auxiliaries.
Feed-water treatment equipment.

ALLOCATION OF POWER GENERATION COSTS

The two systems will now be compared. The incremental decrease in operating costs when going to the high-pressure system will be credited to electric power. The incremental increase in capital costs will be allocated to investment charges for generation of electric power. For calculating with this method, the following *incremental* costs will need to be determined:

1. Fuel costs.
2. Labor costs.
3. Maintenance costs.
4. Water costs.
5. Purchased power costs.
6. Electric-generating equipment costs.
7. Boiler and associated equipment costs.
8. Site preparation, building and foundation costs.
9. Water treatment equipment costs.
10. Electrical equipment costs.

Incremental Fuel Costs

The additional purchased fuel required for electric generation is the major item of increased operating cost that is to be allocated to electric power. Since the heat balances have both been prepared for identical outputs, the difference in their fuel requirements is the incremental increase that is desired. For this example, it is 313.8 − 245.4 = 68.4 MM-B.t.u. per hr. that is required for the generation of electric power.

The following discussion is presented to elaborate upon the heat balances:

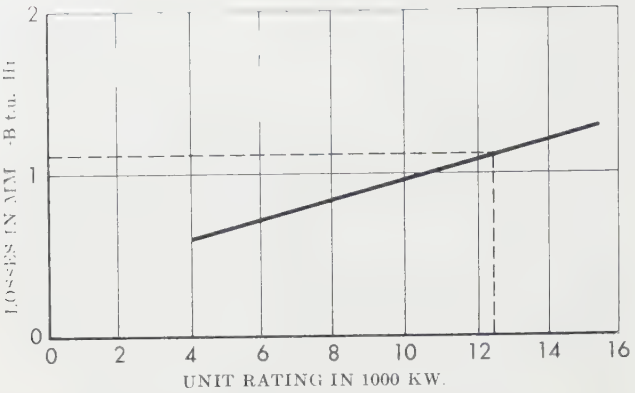


Fig. 9. Radiation, electrical and mechanical losses for different size turbine-generator units each operating at full load (approximate)

Turbine. Flow-output data and extraction enthalpies can be measured on an existing installation; or calculations can be obtained from a turbine supplier. Radiation, electrical and mechanical losses may be estimated from Fig. 9. This curve will be suitable for 3600-r.p.m. straight-condensing, straight-noncondensing or automatic-extraction, turbine-generator units.

For this example it is assumed that the electrical load is at unity power-factor.

Auxiliaries. The auxiliaries associated with the power plant are discussed in two categories: (1) the boiler-feed pump, and (2) all of the other auxiliaries that are required. To assist in estimating these requirements, two graphs are shown (Figs. 7 and 8).

Figure 7 shows the approximate boiler-feed-pump power requirements for different steam conditions and for different boiler flows. For the high-pressure system, the boiler-feed-pump requirements are shown to be approximately 360 kw., and for the low-pressure system 50 kw. These pumps introduce approximately 1.2 and 0.2 MM-B.t.u. per hr. into the feed-water of the high-pressure and low-pressure systems respectively. The incremental heat added to the high-pressure systems respectively. The incremental heat added to the high-pressure system due to increase in boiler-feed-pump work then becomes 1.2 − 0.2 or 1.0 MM-B.t.u. per hr. This increment is chargeable to electric power generation. Note that if this 1.0 were omitted from our 850-p.s.i.g. example, the error this would introduce in the total incremental fuel calculation would be less than 2%. Of course, this would increase with higher pressures.

Figure 8 shows the approximate power requirements for all the other auxiliaries associated with the power plant. From this is obtained the data in Table I, assuming this is not coal-fired and therefore no pulverizers are used:

Boiler. Purchased fuel is burned more efficiently than bark or black liquor. There is also a slight variation in efficiency that could be expected with different purchased fuels. But for this incremental cost method, these differences will be

Table I. Comparative Requirements, in kw.

	Purchase power system	*Generating power system*
Forced-draft fans	162	185
Induced-draft fans	280	323
Circulating water pumps (1 of 2 pumps in use) (Max. steam to condenser = 120,000 lb./hr.)	0	66
Miscellaneous auxiliaries	128	146
	570	720
On adding boiler-feed-pump requirements	50	360
Total	620	1080

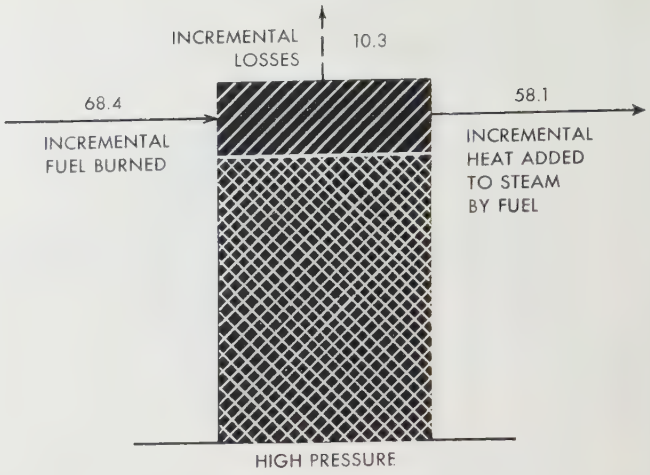


Fig. 10. Charge incremental boiler losses to electric generation

neglected. An 85% boiler efficiency is used for the incremental heat calculations.

The 58.1 MM-B.t.u. per hr. added to the steam will require 68.4 MM-B.t.u. per hr. additional fuel burned (Fig. 10). The incremental boiler losses which must be included in the charge to electric generation are 10.3 MM-B.t.u. per hr.

Incremental Fuel Requirements. With the same heat going to process, the distribution of the 68.4 MM-B.t.u. per hr. incremental heat chargeable to electrical power generation is as shown in Fig. 11, or arithmetically as follows:

Generator output (12,500 kw. × 3413).	42.7	MM-B.t.u./hr.
Turbine & generator losses	1.1	"
Heat rejected to condenser	15.3	"
Total heat removed by turbine, generator, and condenser	59.1	"
Incremental heat added to steam by boiler-feed pump	1.0	"
Incremental heat added to steam by fuel	58.1	"
Incremental boiler losses	10.3	"
Incremental fuel requirements	68.4	"

Assuming a fuel cost of 30¢ per MM-B.t.u. and 8500 hr. per year operation, the fuel chargeable to electric power generation becomes:

$$68{,}400{,}000 \times \frac{0.30}{1{,}000{,}000} \times 8500 = \$175{,}000/\text{year}$$

The following formula gives the fuel heat rate chargeable to electric power generation:

$$\textit{Heat rate} = \frac{\text{(Incremental fuel burned)}}{\text{(Gross generator kw. output)} - \text{(Incremental auxiliary losses)}}$$

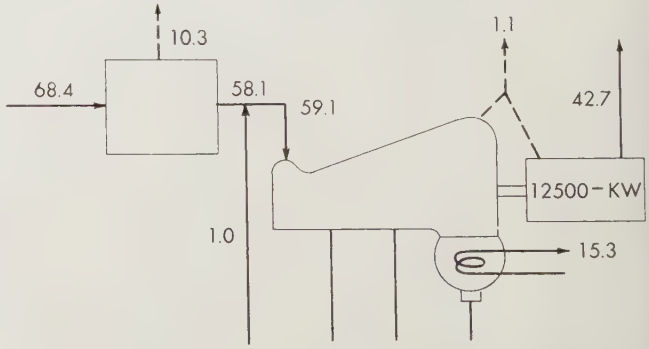


Fig. 11. Distribution of the incremental heat which is charged to electric power generation, MM-B.t.u./hr.

For this example, the heat rate becomes:

$$\frac{68{,}400{,}000}{12{,}500 - (1080 - 620)} = 5680 \text{ B.t.u./kw.-hr.}$$

The unit fuel cost is 300 mils/MM-B.t.u. multiplied by 5680 B.t.u./kw.-hr., or approximately 1.7 mils/kw.-hr.

Incremental Labor Costs

With today's technology it is altogether possible to instrument and automatically control a turbine-generator unit in a manner that would make it suitable for unattended operation. If that were done, there would be no additional operating labor cost for this item, although the equipment would cost more. The evaluation of this is a separate problem. For this example, it is assumed that an extra operator will be on the job for each shift around the clock, and that the additional cost including pay benefits and proportionate supervision will be $35,000 per year.

Incremental Maintenance Costs

Incremental maintenance costs will include that required for the turbine-generator unit, condenser, and feed-water heater, plus any possible amount that might be associated with higher steam conditions on the boilers. This increment is assumed to be $20,000 per year.

Incremental Water Costs

It is assumed that the purchase price of water, or its pumping costs, remain the same with either arrangement.

Each of the two systems has 76,560 lb. per hr. of makeup. The total costs for treating the water are assumed to increase from 4 to 23¢ per 1000 gal. in order to make the water suitable for the high-pressure boilers. This increase in water costs then becomes:

$$\frac{\$}{¢} \times \frac{¢}{gal.} \times \frac{gal.}{\#} \times \frac{lb.}{hr.} \times \frac{hr.}{year} = \frac{\$}{year}$$

$$= \frac{1}{100} \times \frac{23\text{-}4}{1{,}000} \times \frac{1}{8.33} \times \frac{76{,}560}{1} \times \frac{8500}{1} = \$15{,}000/\text{year}$$

Incremental Purchased Power Costs

The purchase cost of power is usually the demand charge, plus the energy charge, plus the fuel adjustment. Add all these charges together and divide by the total kw.-hr. for the period to get the total charge per kw.-hr.

It is further assumed that 12,040 kw. for an 8500-hr. year costs a total of $820,000. This is at an average cost of approximately 8 mils per kw.-hr.

Incremental Electric-Generating Equipment Costs

The equipments to be included here are the turbine-generator-exciter unit, exciter cubicle, voltage regulator, crane, condenser, associated pumps, piping, and additional feed-water heating equipment. For this example, the total installed cost of these items is estimated to be $1,400,000.

Incremental Boiler Costs

The additional costs of recovery, bark, and power boilers as well as piping costs that are attributable to the higher pressure and increased steam flow of by-product power cycle also must be taken into account. It is estimated that the additional investment for this increment will be $300,000.

Incremental Site Preparation, Building, and Foundation Costs

The increase in costs for additional site preparation, building, and foundation is estimated to be $100,000.

Incremental Water Treatment Equipment Costs

It is very likely that a demineralizer will be used for the high-pressure boilers. The difference in equipment costs is assumed to be $75,000.

Table II

	Incremental annual change in operating costs, $
Fuel costs	175,000
Labor costs	35,000
Maintenance costs	20,000
Water costs	15,000
Purchased power costs	−820,000
Total	−575,000

Incremental Electrical Equipment

Sometimes an investment in a substation will be required for the low-pressure system. If so, its capital cost should be segregated as it will be eliminated when all electric power is generated. For this example, it is assumed that one is required when power is purchased and that it costs $250,000 installed.

OPERATING COSTS ALLOCATED TO ELECTRIC POWER

There is a net reduction in total operating costs, which is calculated as in Table II.

The generation of electric power therefore reduces operating costs by $575,000 per year.

CAPITAL COSTS ALLOCATED TO ELECTRIC POWER

In arriving at the incremental capital costs which are charged to electric power, the substation will be dropped out, but all the other capital items will be added as shown in (Table III.

Table III

	Incremental cost, $
Electric-generating equipment	1,400,000
Boiler and associated equipment	300,000
Site preparation, building and foundation	100,000
Water treatment equipment	75,000
Electrical equipment (substation)	−250,000
Total	1,625,000

The total investment cost that is charged to electric power is the incremental $1,625,000. This is $130 per kw.

For the example, it can be seen that an expenditure of $1,625,000 will reduce operating costs $575,000 per year, which gives a gross payout in 2.83 years.

SUMMARY

The hypothetical example of two systems, their comparisons and explanations in this paper show the method and how it is used. The method is, of course, also suitable for use by mills of different sizes and complexities. Mills now generating all their electric power can establish their cost allocations by determining incremental differences with a hypothetical system that is exactly comparable, except using all purchase power and low-pressure boilers. Mills now buying all their electric power can get their cost allocations by making comparisons with a hypothetical system which is exactly comparable except using high-pressure boilers and turbine-generator equipment for which steam conditions have been optimized. When generating part of the electric power and purchasing the rest of it, the method is still applicable.

For a new mill or a mill expansion, this method is especially well suited for determining whether power should be purchased or generated.

And, in every case, such equitable allocations to process steam and to electric power provide the basis for minimizing the total costs of these important utilities.

RECEIVED March 10, 1960. Presented at the 14th Engineering Conference of the Technical Association of the Pulp and Paper Industry, held in Pittsburgh, Pa., Oct. 12–15, 1959.

The writer wishes to acknowledge the wealth of background material supplied by T. J. Judge of International Paper Co., H. R. Emery of St. Regis Paper Co., C. C. Bush of Union Bag-Camp Paper Corp., H. R. Arnold of Continental Can Co., and others of their organizations; also for the very helpful assistance of D. H. Hall and W. B. Wilson of the General Electric Co. in the preparation of this paper.

Purified Egyptian and Syrian Cotton Linters of Low Ash and Silica

M. OMAR, M.A.EL-TARABOULSI, and M. SHERIFF

A series of experimental laboratory cooks were made on Egyptian and Syrian cotton linters to find suitable methods for preparing purified linters of low ash and silica that can be suitable for the cellulose nitrate and rayon industries in Egypt. Caustic soda was used as the pulping agent under different conditions of alkali concentration, temperature, and time. The unbleached and bleached purified linters were analyzed for alpha-cellulose, pentosans, extractives, ash, and silica. The Syrian linters responded to this pulping treatment and gave satisfactory bleached linters analyzing: alpha-cellulose 98.95%, pentosans 1.127%, extractives 0.374%, ash 0.09%, silica in ash 18.31%, and D.P. 2316. Lowering the ash of the Egyptian linters was accomplished by subjecting the raw linters to a preliminary washing with a suitable commercial detergent, followed by alkali digestion and bleaching. This gave satisfactorily bleached Egyptian linters analyzing: alpha-cellulose 98.65%, pentosans 0.93%, extractives 0.134%, ash 0.09%, silica in ash 37.75%, and D.P. 1519. A preliminary study indicated that both purified linters behaved normally during nitration.

EGYPTIAN cotton linters are now being considered as a possible source for chemical cotton for the cellulose nitrate and viscose rayon industries in Egypt. Syrian linters are being imported now, in Egypt, for the cellulose nitrate industry and have proved to be satisfactory.

Attempts to purify the Egyptian linters for the cellulose nitrate industry had met with difficulties and the results obtained were unsatisfactory. The high ash content of the Egyptian linters had proved always to be a major problem. An extensive study particularly on Egyptian linters, was deemed necessary in order to utilize this locally available inexpensive raw material for the required industries.

The present paper describes an extensive study made on both the Egyptian and Syrian linters to find the most suitable methods for preparing purified linters that can be suitable for the cellulose nitrate and rayon industries.

EXPERIMENTAL

Raw Materials

The Egyptian linters were of the "Giza 30" variety and showed nonuniformity as far as length distribution. They were contaminated with dust and hull particles. The Syrian linters appeared to be relatively clean, uniform, of lighter color and of shorter length. The proximate chemical analysis of both linters, which includes ash, ash alkalinity (*1*), nitrogen, total extractives, alpha-cellulose (*2*), beta- and gamma-cellulose (*3*), and pentosans (*4*) are given in Table I. In the alpha-cellulose determination, the holocellulose was treated with 18.6% NaOH and subsequently weighed as alpha-cellulose (*5*).

M. OMAR, Professor of Technology, M. A. EL-TARABOULSI, Lecturer (Pulp and Paper), Chemical Engineering Dept., Faculty of Engineering, Alexandria University, Egypt. M. SHERIFF, Chemical Engineer.

Table I. Proximate Chemical Analysis of Raw Linters

Linter type	*Egyptian* [a]	*Syrian* [b]
Moisture, %	8.35	7.75
Ash, %[c]	3.39	1.46
Ash alkalinity	19.69	16.23
Nitrogen, %	0.59	0.29
Ether extractives, %	1.24	0.40
Alcohol-benzene (1:2) extractives, %	1.95	0.52
Cold-water extractives, %	2.34	1.97
Total extractives, %	5.53	2.89
Alpha-cellulose, %[d]	78.7	90.7
Beta- and gamma-cellulose, %	4.26	1.57
Beta-cellulose, %	0.31	0.12
Pentosans, %	2.56	1.71

[a] The average length of the linters is 2.05 cm. and average diameter 0.0177 mm.
[b] The average length of the linters is 0.925 cm. and average diameter 0.0265 mm.
[c] All values except moisture are on ovendry basis.
[d] Corrected for ash.

The analytical data showed that the Syrian linters contained less ash, ash alkalinity, nitrogen, extractives, and pentosans but higher in alpha-cellulose content in comparison to the Egyptian linters. The Egyptian linters were about twice the length as of Syrian linters, but of smaller diameters.

Linter Purification and Testing

The Egyptian linters were cut to a length of about 1 cm. An orienting series of 150-g. cooks were carried out on both types of linters in a gas-heated, stationary, vertical laboratory autoclave, using NaOH as the chemical agent at the specified conditions shown in Table II. Following digestion, the linters were washed free of alkali, recharged into the autoclave and heated in the presence of water for 45 min. at the digestion temperature. After removal from the autoclave the linters were washed ten times with water, given a souring treatment with 0.5% H_2SO_4 (based on ovendry linters) for 20 min. at room temperature and the linters finally washed free of acid. The data on the chemical characteristics of the purified linters are given in Table II. The D.P. was determined by the cuprammonium viscosity method (*6*).

The results in Table II, with reference to Egyptian linters, show that, in general, increasing the alkali concentration from 1.5 to 3.5% did not have any significant effect on the ash and alpha-cellulose contents; with the lowest extractives and pentosans contents obtained by using 1.5% alkali concentration (at 130°C). There is an expected gradual decrease in D.P. with increase in alkali concentration.

Increasing the time of digestion from 6 to 12 hr. did not prove to be beneficial and increased the extractive content, as seen by the comparison of cooks no. 3 and no. 5.

The effect of temperature of digestion is significant, the optimum temperature being 130°C. By digestion at this temperature, using 1.5% alkali concentration for 6 hr., the minimum ash and extractive contents were obtained. Increasing the temperature of digestion resulted in an expected gradual decrease in the D.P.

By applying the optimum conditions of digestion (cook no. 3) on both the Egyptian and Syrian linters, it was found that the ash content of Syrian linters was much lower than that of the Egyptian linters, as seen from a comparison of cooks no. 3 and no. 14. Also, the yields of the Syrian cooks and the D.P. were higher than that of the Egyptian cooks. However, the optimum Egyptian cook no. 3 was lower in extractives and pentosans in comparison with the Syrian cook no. 15.

It is clear from Table II that the ash content of the purified unbleached Egyptian linters was high and unsatisfactory. Varying the digestion conditions did not lower the ash content to any significant degree. Attempts were thus made to decrease the ash content of the purified unbleached Egyptian

Table II. Linter Purification: Cooking Conditions, Yields, and Chemical Properties of Purified Unbleached Linters

Cook no.	Linter type	Cooking conditions: NaOH,[a] %	NaOH concn., %	Time of cook, hr.	Temp., °C.	Yields, %	Chemical constants[b]: Ash, %	Alpha-cellulose, %	Extractives,[c] %	Pentosans, %	D.P.
1	Egyptian	14.86	1.5	6	110	71.84	1.23	96.55	0.672	0.866	2726
2	Egyptian	14.86	1.5	6	120	72.84	1.57	97.4	0.456	1.209	2648
3	Egyptian	14.86	1.5	6	130	71.0	1.1	97.5	0.35	1.06	2556
4	Egyptian	14.86	1.5	6	140	70.23	1.16	97.3	0.78	0.835	...
5	Egyptian	14.86	1.5	12	130	68.6	1.25	96.27	0.94	0.785	...
6	Egyptian	24.77	2.5	6	110	75.1	1.03	95.3	0.85	1.79	2662
7	Egyptian	24.77	2.5	6	120	71.2	1.1	96.7	0.53	1.63	2632
8	Egyptian	24.77	2.5	6	130	69.1	1.14	96.99	0.531	1.24	2502
9	Egyptian	34.68	3.5	6	110	73.24	1.23	96.67	0.63	0.9	...
10	Egyptian	34.68	3.5	6	120	71.1	1.14	97.4	0.74	1.24	2594
11	Egyptian	34.68	3.5	6	130	69.5	0.97	94.9	0.91	1.07	2279
12	Syrian	14.86	1.5	6	110	87.2	0.23	97.61	0.842	0.659	3082
13	Syrian	14.86	1.5	6	120	84.8	0.21	97.2	0.949	0.652	2863
14	Syrian	14.86	1.5	6	130	84.5	0.24	96.49	0.689	0.651	2762
15	Syrian	14.86	1.5	6	130	78.14[d]	0.16	96.54	0.76	1.29	2849

[a] Based on the ovendry weight of linters.
[b] Based on ovendry unbleached linters.
[c] Ether and alcohol-benzene (1:2) extracts.
[d] Cook no. 15 was done on a different batch of Syrian linters, which accounts for its different yield.

linters by applying extensive washing, souring, and bleaching studies. The results are shown in Table III.

As seen from Table III, increasing the number of washings lowered the ash content. Souring with H_2SO_4 of the unbleached purified linters was also effective in lowering the ash content. The H_2SO_3 souring of the bleached linters showed a gradual decrease in ash content by increasing the amount of acid used in souring. However, all the results, shown in Table III did not lower the ash content to the desired value, and a new approach for solving this problem was pursued. It was

Table III. Ash Lowering of Digested Egyptian Linters by Washing, Souring, and Bleaching

Cook no.	No. of washings: 3	10	20	Ash content: Souring with H_2SO_4[a] 0.5%	1%	Souring of bleached linters with H_2SO_3[b] 0.5%	1%	1.5%
6	1.46	1.032	0.81					
7	1.33	1.1						
8		1.14		0.98	0.72			
8	1.63					0.875	0.715	0.45
8	1.63			0.98				0.42
8	1.63				0.72			0.26

[a] Based on ovendry linters.
[b] Bleaching was done using 1% available chlorine in the form of NaOCl (based on ovendry linters), pH 8 to 9, temperature 38 to 39°C., consistency 3%. The time of H_2SO_3 treatment was 30 min. at room temperature, followed by washing till free of acid.

thought that the soil clinging to the Egyptian linters has to be removed by a preliminary washing treatment with a suitable commercial detergent before digestion. Experiments carried out along this direction were satisfactory and the results are shown in Table IV.

The results in Table IV show that preliminary washing of the linters with a suitable detergent is of utmost necessity in effecting the lowering of ash to the desired content, as seen in cook no. 19 where the ash was lowered to 0.34%. It should also be noted that the addition of the detergent in the cook alone has a little effect on lowering the ash, as seen in cook no. 23, but the detergent effect is very pronounced if the linters are subjected to a preliminary washing treatment prior to digestion, as seen in cook no. 16 and no. 19. As seen in Table IV, different commercial detergents gave different results, with detergent no. 2 giving the best results. The maximum lowering of the ash was effected by subjecting the raw linters to a preliminary washing treatment with 1% detergent (no. 2), followed by digestion in the presence of 1% detergent at 130°C., using 1.5% alkali concentration for 6 hr. (cooks no. 19 and no. 22). The minimum ash content of the unbleached purified linters in the latter cooks were 0.34 and 0.35%, respectively.

Bleaching of Purified Linters

Purified linters (cooks no. 24 and no. 15 in Tables IV and II, respectively) were bleached with NaOCl using the conditions stated in Table V. The bleaching was carried out at 5% consistency with occasional stirring at the specified temperatures, keeping the pH between 8 and 9 for a period of $1^1/_2$ hr. This is followed by washing and souring with 1.5% H_2SO_3 at 5% consistency at room temperature and washing free of acid. The results in Table V show that the bleaching of Egyptian and Syrian linters gave bleached linters of satisfactory analysis.

The finally purified and bleached linters analyzed as follows:

	Egyptian linters	Syrian linters
Alpha-cellulose, %	98.65	98.95
Extractives, %	0.134	0.374
Pentosans, %	0.93	1.127
Ash, %	0.09	0.09
Silica in ash, %	37.7	18.3
D.P.	1519	2316

Table IV. Egyptian Linters Pretreatment, Cooking Conditions, Yields, and Chemical Properties of Linters

Cook no.	Pretreatment[a]: Detergent types[b]	Detergent, %	Ash in pretreated linters, %	Cooking conditions: NaOH, %	Detergent, %	NaOH concn., %	Temp., °C	Time of cook, hr.	Yield, %	Chemical constants: Ash, %	Alpha-cellulose, %	Pentosans, %
16	1	1	1.39	11.79	Nil	1.5	130	6	68.43	0.562	95.7	1.035
17	1	2.5	1.08	11.82	Nil	1.5	130	6	74.4	0.65	98.01	0.801
18	2	1	..	14.86	Nil	1.5	130	6	72.13	0.402	97.5	...
19	2	1	..	14.86	1	1.5	130	6	65.1	0.34	...	...
20	2	1	..	14.86	2	1.5	130	6	...	0.48	...	...
21	3	1	..	14.86	Nil	1.5	130	6	...	0.79	...	...
22[d]	2	1	..	14.86	1	1.5	130	6	66.43	0.35	97.9	...
23	..	Nil	..	14.86	1[c]	1.5	130	6	...	1.2	...	...
24	2	1	1.2	14.86	Nil	1.5	130	6	67.76	0.51	97.25	1.03

[a] In the pretreatment process, linters were treated with the desired amount of detergent (the percentage based on ovendry linters), using 10:1 liquor good ratio, with occasional stirring at about 80°C. for 15 min., followed by washing with water.
[b] Detergents 1, 2, and 3 are commercial detergents.
[c] Detergent type 2 was used.
[d] Cooks no. 19 and no. 22 were done under the same conditions on two batches of Egyptian linters to check the consistency of the results.

Table V. Bleaching of Egyptian and Syrian Linters: Bleaching Conditions and Chemical Properties of Bleached Linters

Cook no.	Ash (digested linters before souring), %	Ash[a] (soured linters), %	Bleaching conditions: Available chlorine, %	pH	Temp., °C.	H_2SO_3, %	Time of H_2SO_3 treatment, min.	Chemical constants: Ash, %	Silica in ash, %	Alpha-cellulose, %	Extractives, %	Pentosans, %	D.P.
24[b]	0.791	0.51	1.5	8–9	40	1.5	45	0.09	37.7	98.65	0.134	0.93	1519
24	0.791	0.51	0.75	8–9	24	1.5	30	0.19	37.7	97.6	0.43	1.04	2169
15[c]	0.51	0.16	1.5	8–9	35	1.5	30	0.09	18.3	98.95	0.374	1.127	2316

[a] Soured with 0.5% H_2SO_4, based on ovendry linters.
[b] Cook done on Egyptian linters, pretreated with 1% detergent no. 2, digested with 1.5% alkali concentration at 130°C. for 6 hr.
[c] Cook done on Syrian linters, no pretreatment, digested with 1.5% alkali concentration, at 130°C. for 6 hr.

The analysis of both purified and bleached linters can be considered, chemically, as suitable for the cellulose nitrate and rayon industries. Preliminary nitration studies carried out on the purified bleached and unbleached Egyptian and Syrian linters gave satisfactory results.*

DISCUSSION AND CONCLUSION

Egyptian and Syrian cotton linters were cooked by the alkali process under different conditions of alkali concentration, temperature and time, and the linters subjected to different washing, souring and bleaching studies. The results are shown in Tables II to V.

Of interest in this study is that the lower alkali concentration was more beneficial in giving the optimum results than the higher and more expensive alkali concentration. The optimum result for alkali digestion for both types of linters was found to be 1.5% alkali concentration at 130°C. for 6 hr.

The study has resulted in showing clearly that the ash content of the purified unbleached Egyptian linters was always much higher than the Syrian linters. Lowering the ash of the Egyptian linters was successfully accomplished by subjecting the raw linters to a preliminary washing with a suitable commercial detergent prior to alkali digestion and bleaching, and this resulted in lowering the ash content of the Egyptian linters to the desired value.

It is evident from the data that the finally purified, bleached Egyptian and Syrian linters were of comparable alpha-cellulose and ash contents, with the Egyptian linters being lower in extractives and pentosans; in spite of the fact that the starting raw Egyptian linters were much higher in ash, extractives, and pentosans.

The data show that the Syrian linters are of a higher D.P. than the Egyptian linters.

The results obtained in the present investigation show that, technologically, Egyptian linters can be considered as a suitable raw material for the cellulose nitrate industry; and chemically, they can also be considered suitable for the rayon industry. This holds true also for the Syrian linters. The Egyptian linters show sufficient promise to warrant large-scale trials on its digestion and nitration.

LITERATURE CITED

1. Dorée, C., "The Methods of Cellulose Chemistry," Chapman & Hall, Ltd., London (1947), p. 16–17.
2. Wise, L. E., Murphy, M., and D'Addieco, A. A., *Paper Trade J.* 122, No. 2, 35–43 (Jan. 10, 1946).
3. Dorée, C., "The Methods of Cellulose Chemistry," Chapman & Hall, Ltd., London (1947), p. 364–365.
4. Institute Methods No. 424, 1952.
5. Dorée, C., "The Methods of Cellulose Chemistry," Chapman & Hall, Ltd., London (1947), p. 363.
6. Battista, O. A., *Ind. Eng. Chem., Anal. Ed.* 16, 351–354 (1944).

* The nitration results are to be published later.

This paper is taken in part from the thesis presented by M. Sheriff in partial fulfilment of the requirements of Alexandria University, for the degree of M.Sc.

The author wishes to acknowledge the grant offered by the National Research Council, Cairo, U.A.R. that made this work possible.

Received Sept. 24, 1959.

Use of Titanium in Pulp Bleaching Equipment

G. W. BAUER

The important physical and mechanical properties of titanium are presented, along with a brief description of its extractive metallurgy, melting, welding, fabrication, and mill products available. The rapid growth of chlorine dioxide bleaching and the severe corrosion problems resulting from this process are discussed. Until titanium had been utilized, no metal was completely satisfactory for chlorine dioxide bleaching equipment. The corrosion resistance of titanium in chlorine dioxide solutions, or gas, is excellent. The inherent characteristics in titanium which affect its corrosion resistance are mentioned. Titanium has been used in several applications in chlorine dioxide bleaching. Some parts have been in service for almost 6 years with no apparent corrosion. Increased usage of titanium is predicted because of steadily decreasing prices and increasing knowledge of its corrosion resistance.

PROPERTIES OF TITANIUM

Before discussing applications for titanium in pulp bleaching equipment, perhaps a short discussion of titanium metal would be in order: What is it? . . . How do its properties compare with those of other metals? . . . How is it made?

Titanium is a relatively new industrial metal. Although discovered late in the eighteenth century, a practical and economical method for reducing it from the ore was not developed until 1938; and the pure sponge, the raw material for our present industry, was not commercially available until 10 years later. Since that time almost 20,000 tons of titanium alloy mill products have been produced, with an estimated market value of $500 million. Titanium must certainly have some outstanding properties for an industry of such stature to have developed in a decade.

Titanium ores are quite abundant in the earth's crust; in fact, titanium ranks fourth among the metallic elements, being exceeded in quantity only by magnesium, iron, and aluminum. Titanium's strong affinity for oxygen, however, makes it mandatory to carry out ore reduction and melting in batch-type processes in either inert gas or vacuum. Titanium ingots are arc-melted in vacuum, using consumable electrodes and a two-stage melting process for alloy homogeneity. After melting, titanium may be processed similarly to steel, and rolling and forging operations are normally carried out between 1200 and 1800°F.

The tensile strength of titanium ranges from 30,000 p.s.i. for high purity metal, to over 200,000 p.s.i. for age-hardened titanium alloys. Commercially pure titanium has a tensile strength of 80,000 to 100,000 p.s.i. The high strengths of titanium alloys at temperatures up to 1000°F., combined with titanium's light weight (56% that of stainless steel) have resulted in many applications in aircraft and missiles. Its

G. W. Bauer, Manager of Commercial Market Development, Reactive Metals, Inc., Niles, Ohio.

outstanding corrosion resistance has led to many industrial applications, particularly in the chemical and related industries. The electrical and thermal conductivity of titanium are quite low; in fact, its electrical resistivity is unusually high for a pure metal. Some titanium alloys have higher specific resistance than the common resistor metals.

Titanium is available in many mill product forms including sheet, bar, billet, tubing, foil, wire, and in several special forms such as angles, wire mesh, expanded sheet, pumps, and valves. The wide use of titanium by aircraft plants over the past decades has led to an extensive development of welding, machining, and fabrication techniques. Arc welding is accomplished with inert gas shielding, but spot welding requires no protective measures. Titanium may be forged, stretch formed, spun, and deep drawn.

CORROSION PROBLEMS IN PULP BLEACHING

Discussion in this paper will be concerned primarily with chlorine dioxide bleaching, a process which may be likened to the titanium industry. Although relatively new, having first been used in 1946, it is rapidly gaining wide acceptance as the best method for bleaching pulp to high brightness levels without loss of pulp strength. The consumption of sodium chlorate by the pulp and paper industry for the generation of chlorine dioxide has increased from less than 7000 tons in 1954 to more than 30,000 tons in 1959, a growth rate much greater than that of the industry as a whole.

It is doubtful whether more severe corrosion problems are encountered in any industrial process than in chlorine dioxide bleaching. The handling of sodium chlorate and the generation and storage of chlorine dioxide present no major problems. Mild steel and plastic, lead, or acidproof brick-lined equipment usually give satisfactory service. However, in chlorine dioxide bleaching equipment, particularly in the mixer, corrosion can be quite severe. The optimum operating conditions for chlorine dioxide bleaching are at 160°F. for 3 to 5 hr. at a pH of 6, but decreasing pH and the escape of chlorine dioxide from the solution because of low solubility leads to a very corrosive atmosphere.

No material had been entirely satisfactory for chlorine dioxide mixers until the advent of titanium. All metals previously used were subject to pitting, crevice or galvanic corrosion, or selective corrosion in weldments. Titanium can be alloyed for high strength but is normally used as a pure metal for corrosion-resisting applications, since it is stronger than most common structural metals in this condition. Titanium is a very noble metal and is readily passivated; in fact, its passivating oxide film is considerably harder to break down than those of the stainless steels. Titanium weldments are single phase and have the same corrosion resistance as the base metal. The net effect of these characteristics results in a metal which is attacked slowly, if at all, in practically all corrosive media. The corrosion rate for titanium in strong chlorine dioxide solutions at 160°F. is less than 0.1 mil per year. Titanium is also highly resistant to calcium and sodium hypochlorites. It is attacked in strong reducing solutions unless inhibitors are added.

APPLICATIONS FOR TITANIUM

Titanium equipment has been in operation in one paper plant for almost 6 years, but it has only been within the past 2 years that widespread acceptance of titanium by pulp and paper plants has come about. An important factor in this increased usage has been the development of several well-qualified fabricators who can now furnish excellent titanium or titanium-lined equipment.

The largest single use for titanium in pulp and paper equipment has been as liners for chlorine dioxide mixers. These are generally $^1/_8$ to $^1/_4$ in. thick for ease in fabrication, and mild steel can be used satisfactorily for the outer construction. One titanium-lined mixer has been in service for over 5 years and, at last report, the titanium was virtually untouched. Approximately 10 mixers were lined with titanium in 1959 and, since it is the only completely dependable metal for this service, its use in 1960 should be greater.

Other applications for titanium in chlorine dioxide bleaching equipment have been in thermowells, nozzles, orifice plates, rotameter floats, radial flow mixers, and scraper arms. Experiments are under way at the present time to evaluate titanium facing wire on a pulp washer, since stainless steel is subject to crevice corrosion. Eventually, entire washers will probably be made of titanium to eliminate neutralization costs and to achieve indefinite equipment life.

Titanium is the only structural metal whose prices have decreased steadily for the past 6 years. At the present time, some forms of titanium are directly competitive with high-nickel alloys. The combination of continuous corrosion testing and the resulting reduction, if not elimination, of replacement and maintenance costs will lead to many more economical applications for titanium.

Received April 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

A Practical Approach to Open Side Calender Design

JOSEPH E. PERKINS

A discussion of the method used by engineering to improve the design of open side calenders. Before actual design word was started a complete review was made of all the requirements needed to produce a good calender. This review involved a complete investigation of the following four items: proper sizing of the equipment for the job, arranging components for ease in operating, designing for easy service, and providing for the addition of accessories. The results obtained by this approach are illustrated by describing some of the important design features of the calender in terms of the four basic items noted above.

Today the design engineer has many new and novel devices, ideas, and material available for his selection. If a practical approach is not used when designing paper mill machinery, the design usually becomes so overladden with new ideas and improvements that the original intention of building simples, easily operated, serviceable equipment becomes secondary and may be forgotten. The result may satisfy the design engineer but usually does not satisfy the operator.

Most engineers have at least once during their career, struggled to design and produce a new piece of equipment only to hear as a final comment: "That sure is a fine looking piece of machinery but. . . ." Many times the but is justified. It should have been eliminated during the initial design stages.

This is particularly true of paper mill machines, which must be rugged, and capable of operating continuously with a minimum number of breakdowns.

A short time ago it was decided to redesign and improve our line of open side calenders. Before actual design work was started a complete review was made of all the requirements needed to produce a good calender. This review, which I refer to as the "practical approach," involved a thorough investigation of the following four basic items.

1. Proper sizing of equipment for the job.
2. Arranging components for operating ease.
3. Designing for fast, easy service, and maintenance.
4. Providing for the addition of accessories.

Joseph E. Perkins, Design Engineer, The Black-Clawson Co., Inc., Paper Machine Division, Watertown, N. Y.

The open side calender has definite operating advantages over the closed stack. It is more compact, requires less floor space, allows faster roll removal, etc. These advantages, however, do not come automatically but must be carefully incorporated in the design. The end result of all this planning is to satisfy the customer. The results attained by this approach can best be illustrated by describing some of the important design features in terms of the four basic items of the "practical approach."

We feel these items make for a superior calender.

Frames. The basic design consists of cast iron frames with the upright column a closed box section to provide maximum rigidity.

Roll Pivot Arms. The long arms supporting the rolls assimilate the straight up and down movement of a closed frame stack, yet provide roll stability which cannot be attained in the closed stack. The supporting arms go around both sides of the upright frame and are connected by pins to mounting brackets. These brackets are T-bolted to the frame and are adjustable vertically. The long pivot arms keep the rolls in close vertical alignment. Stabilizing screws in the arms contact the frames, stabilizing the arms in a cross the machine direction. Horizontal arm position can easily be maintained. Long pivot arms minimize the nip loading due to doctors, footwalks, etc.

Roll Lift. The mechanical roll lift consists of a right angle gear motor mounted on the drive side, on a cross-beam between the frames. It is shaft-connected to two worm gear jacks, one mounted on the front and one on the back side. Nonrotating threaded rods extend down from each jack in front of the upright frame through each roll arm. Adjustable self-locking nuts are located under each arm. The drive is self-holding. The lift will separate and hold the rolls up for operating with reduced nips, or for roll removal, without additional blocking. It also allows removal of a roll without disturbing the rolls underneath. Upper rolls can be removed with the lower rolls in operation.

Roll Removal. Roll removal is easily and quickly accomplished by removing the monogramed cover from the outside of the bearing housing. Lift pins are inserted in holes in each end of the roll. Slings from an overhead crane are attached to the lift pins. The bearing housing is unbolted from the pivot arm. The roll can then be swung clear and lowered to the floor. When steam joints are used, the rotary joint and adapter flange are removed. Pins are then inserted in the ends of the journals and the roll is removed as above. Note that the roll lift is not disturbed, even when the roll is being removed.

Lifting of the roll for removal does not affect the roll above or below.

Doctors. The doctors and water boxes for all rolls, except the bottom roll, are mounted on the roll bearing housings. Doctors are used to keep the rolls clean and prevent wraps.

Mounting on the housings keeps the doctor blade parallel to the axis of the roll and exerts equal pressure over its full length, at all times.

Roll movement, when raising or lowering, or owing to changes in sheet caliper or threading, does not disturb the setting.

Long pivot arms minimize the affect of doctor weight on the roll nip. Where this weight becomes appreciable, bearing compensators (air diaphragms) are used at the front of each bearing housing to counterbalance all weight beyond the roll face, such as doctor, bearing, and housing.

Cover. A sheet metal cover is located outside the vertical frame of the calender to house the oilers, lubrication, air, steam and water cooling lines. Flexible hose lines connect the lines from the cover to the bearing housings.

The cover is quickly opened for access to these lines. It protects the lines from damage and gives the calender a clean look.

Air Loading. Air cylinders are located on each top beam and pin connected to the front of the top roll bearing housings. They are in the open and easily reached for servicing.

Loading in front of the bearing, combined with the long pivot arm, gives a high lever ratio which permits the use of smaller cylinders and reasonable air pressures. If desired long bars are available for loading any roll.

Controls. The operating controls are centrally located in a console type cabinet. The calender is so designed that a stripped down stack can be supplied and accessories added later without custom fitting.

A full line of accessories is available as follows:

Roll cooling of heating.
Bored rolls with bolted heads.
Hydraulic bottom roll remover.
Bearing compensators.
Circulating or micro fog oil systems.
Overhead crane.
Sheet threaders.

The initial cost of a calender is not the only cost to be considered. By the very nature of its operation a calender will require considerable service during its life, i.e., rolls are removed frequently for regrinding.

Particular attention has been paid to arrange the components of the calender for fast, easy service to keep this cost to a minimum.

We, at Black-Clawson, are constantly working on new ideas to improve our calenders. The latest design improvement is an open side calender equipped with a mechanical device for maintaining a uniform nip at the bottom roll under varying nip-pressure loads, without regrinding the crown on the bottom roll. A double open side calender stack equipped with this device is now being built and will be placed in operation in the near future.

The advantages are:

1. One bottom roll with a fixed crown.
2. No regrinding of roll crown when changing the number of intermediate rolls in contact with the bottom roll.
3. Deflection of bottom roll controlled from console.

This calender will be the subject of a paper to be presented in the near future.

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York N. Y., Feb. 22–25, 1960.

Rope Carrier Practices

H. H. MULLINS

There are several types of rope carrier systems, one being the single rope system which uses one continuous rope doubled back upon itself. In mills having three- and four-deck stack drying systems on heavy board machines, a three-rope system is often used. However, the majority of rope carriers are a two-rope system. There are several types of transfers for passing the sheet from one section to the next. Some mills use automatic transfers; others use a more flexible transfer system which permits the tail to be pulled out if necessary and then fed back into the next section at the appropriate time. Ropes used in rope carrier systems were originally made of cotton, but spun nylon is now widely used. This rope has the advantage of long life without the undesirable high breaking strength of filament nylon. Rope life is primarily dependent upon proper tension, well designed correctly aligned sheaves, and proper splices.

Rope carrier practices have been found to be as varied as it is possible to make them. It appears that there is as much art to making a good rope run as there is in any craft

H. H. Mullins, Olin Mathieson Chemical Corp., West Monroe, La.

or profession. Usually, in each mill, one man is considered the rope expert and his rope run is the only one that is acceptable; consequently, there is considerable confusion surrounding rope practices that needs to be clarified and a few things that have been gathered together will be presented.

The rope run usually begins at or just before the first drier and with the tail under the inside rope and over the outside rope. At some transfers the procedure is reversed.

ROPE CARRIER SYSTEMS

There are several types of rope carrier systems, one being the single-rope system. This does not imply that there is only one rope carrying the paper. It actually means that there is a continuous rope that doubles back upon itself forming a two-rope system. It is used for carrying the tail over a section of the machine which is not too long for a single rope to be used. Such a system is often employed in a rope carrier from the calender to the reel. It is also employed at a size press on a machine that does not have a rope carrier through the driers. In that case a large rope sheave is put on the first drier after the size press and this rope sheave does the driving for the entire system. The tail is picked up as it comes off the last drier ahead of the size press and is taken by the rope through the size press, over the paper rolls, spreader rolls, etc., and around the first drier after the size press where it is again passed by hand.

Another type of rope system is the so-called three-rope system. This is employed on many machines where there are three- and four-deck stack drying systems with long upward draws and which make fairly heavy board.

In connection with rope systems on board machines with long draws, one mill was using a rope on a three-deck system and was plagued with slack accumulation, particularly in the long up- and-down draws. The machine was driven with a lineshaft with seven drive-in stands in the drier section and was equipped with motor operated belt shifters. Their solution to the problem was to install all belt guides on air cylinders set to throw the belts approximately 2 in. to the fast side of the pulley. Each section is overspeeded while bringing the sheet over until the slack is pulled up, then by throwing a lever the belt returns to the original setting.

TRANSFERS

The problem of transfers is perhaps one of the most controversial issues among good papermakers the country over. There are several types involved. Some are positive types of transfers wherein one of the incoming ropes will go under the tail, following which one of the outgoing ropes will leave the sheet as it goes over a paper roll or as it goes over the drier. Then, the second incoming rope is laid on top of the incoming rope that is already in place. The second outgoing rope will leave. This is a positive transfer.

Another type transfer is set up in such a manner that the tail is actually dropped from one set of ropes into another set of ropes. The outgoing ropes form a V with the point upward and the incoming ropes form a V with the point downward. A distinct advantage of this type of pass is the fact that it is possible to pull the tail out of the outgoing rope, thus eliminating the automatic pass, and then later putting the tail in the incoming rope at the operator's convenience or desire. It is not practical to do this with a positive transfer. If the V type transfers can be made to operate in a downward position as close to the vertical as possible, so that the incoming V is below the outgoing V, the rope system will work satisfactorily at all times. Such a system will also work on a horizontal run; however, we have never been able to make one work in an uphill direction.

Another interesting rope run is that wherein a certain section such as a size press will be roped up under normal operations and bypassed when making other grades. This is not an easy change because it necessitates lifting one of the rolls and sliding the rope out or some other complicated means of having the rope bypass the press. It is possible, however, to rope the section in such a manner that the operator only has to slide the ropes off the sheave and does not have to get them around the journals and bearings of any roll. The way to do this is to bring the two ropes between the two size press rolls, around the sheaves, and then back between the two rolls without forming a loop around the journal of either of the size press rolls or any of the auxiliary paper carrying rolls. This sounds very complicated, but actually is simple to do.

The rope carrier system for paper machines was invented by William Sheehan, Superintendent of the Wilmette Pulp & Paper Co., and was installed in that company's mill at Oregon City, Ore., in 1913.*

The grooves carrying the ropes were originally cast with the heads and were still being cast in the heads of the paper machine driers as late as 1924. In the early twenties separate sheaves bolted to the drier heads came into use. The present trend is back to the sheave cast in the drier head.

KINDS OF ROPE USED

Cotton rope was used as the carrier rope until in the late forties, at which time nylon was introduced and was used by several paper mills. In 1947 nylon rope was tried with considerable success and a report of this successful use was given before the Joint Fall Meeting of the Southern and Southeastern Division of the American Pulp & Paper Mill Superintendent's Association on Oct. 10—12, 1951. In 1948, one company began to replace their cotton carrier rope with nylon ropes and the resulting cost reduction was very impressive.†

Considerable experience at other mills was of a similar nature. However, there were some sad experiences in other places. It became apparent to the industry that nylon rope comes in two forms—filament and spun. Filament nylon is made of almost continuous threads the entire length of the rope which gives it a high breaking strength. Because of this high breaking strength, considerable damage was done to some paper machines before this undesirable characteristic was recognized. The fibers in spun nylon rope are much shorter.

	Tensile strength, lb.	*Net wt., lb./100 in.*	*Tensile strength, lb.*	*Net wt., lb./100 in.*
Cotton	1000–1500[a]	4.0	1800–2500	8.0
Spun nylon	2300–2500	3.6	3800–4000	6.0
Filament nylon	2600–2800	3.5	4500–5000	6.5
50% Cotton 50% Nylon	2000	..	3300	..

[a] Upper and lower limits given by various manufacturers.

At our mill our first experience with nylon was with the filament type in the early 1950's and we were not happy with its performance.

In 1958 we investigated the different types of nylon including filament, spun, and the 50% cotton-50% nylon combination. We are now using the 50–50 cotton-nylon rope on our board machines where the rope size is $^5/_8$-in. diameter. These rope carriers each consist of two ropes which carry the tail of the sheet of board up to and including 120 lb. (1000 sq. ft. basis weight).

On our paper machines we are now using $^3/_8$-in. spun nylon rope very successfully. The only trouble we have had is with a reel of rope that we borrowed. The first rope from this reel was used on our size press section and it disintegrated in

* Private papers.

† R. W. McCormick, *Southern Pulp & Paper Mfr.*, Dec. 1951, page 74.

2 day's time. Since then we have taken samples of nylon ropes and cotton ropes of all types and placed them in the solutions used in the size press but have not as yet been able to repeat this disintegration.

Most of our rope trouble is due to knocking the ropes off the sheaves. On one of our board machines, where we have a coater installed between the two calender stacks, we at first experienced considerable difficulty in transferring the tail after the first calender, even though we went so far as to putting the tail in the ropes, hitting it with a mop set in a glue bucket. This worked successfully for some time until, as in all mill startups, the men and machinery met on a common ground and the problem was solved; we have not had any difficulty since then. We have never used three ropes to carry a tail through our two board machines, one of which has 108 driers and the other has 87 driers.

FUNDAMENTAL FACTORS INVOLVED IN ROPE LIFE

There are three fundamental factors involved in rope life. One is the amount of tension carried on the ropes, another is sheaves and their alignment, and the third is splices.

Tension is produced either through weights or through an air loaded cylinder. It has been our experience with the weight loaded stretches that it is necessary to carry a weight of 30 to 40 lb. on the rope stretch at all times with an additional 40-lb. weight being placed on the rope stretch while threading the tail through the machine. This additional weight is removed as soon as the sheet is over. In a similar manner, on the air-loaded stretches sufficient pressure is applied to hold the tail between the ropes until the sheet is over the machine and then the pressure is relieved down to, possibly, 10 lb. to improve the rope life.

The second factor mentioned above was the sheaves and their alignment. The sheaves should be aligned to prevent the ropes from rubbing against the frames of the machine and idler sheaves, or anything that is stationary, that has a square edge, or that will chafe the rope. This is true of nylon as well as cotton, and, in fact, it will narrow the long service life advantage of nylon over cotton. The flange of the pulley should not be used to force the rope into alignment around the pulley. A rope should always come squarely into a sheave. That is, the sheave should be parallel to the plan of the incoming rope. If there is an angle in the rope at the sheave, it should all be where the rope leaves the sheave. It is very important that the sheave and idler pulley be so aligned that the ropes do not rub against the flange of the sheave. If the rope has to depart from the vertical or horizontal plane, then, if possible, an idler sheave should be installed with the axis perpendicular to the plane. With a well-aligned rope carrier system, the only time the ropes will jump off is when the operator lets too big a wad of paper go through, forcing the ropes out of the sheaves.

The depth of the groove in the rope sheave and the angle of flair of the sides of the sheave is a subject on which, as far as we have been able to determine, nothing has been published. In fact, a cursory check of the literature indicates only one reference‡ than the one cited on the entire subject of rope carriers.

Sheaves were originally manufactured of cast iron and were cast and furnished on an "as is" basis. We understand that considerable work has been done on casting sheaves of an abrasion resistant aluminum alloy. Our experience has been that if a sheave with blow holes or machine marks in the grooves is used, it is best to grind these out because the wear caused by the imperfect surfaces of a sheave is far greater than most people realize.

One of the most important factors in rope carrier life is the splicing. This subject could use a considerable amount of investigation and research as many of the mills that have rope carriers do not know how to splice a rope, some mills use buckles. In any event, large splices and buckles serve only to wear ropes and sheaves.

There is some art in splicing ropes and there are a considerable number of tricks which may be found useful, one being to smear some machinist's blue or chalk, or even grease, on the outside of the rope where the splice will be made, so that when the strands are laid back in, there will be something to guide the splicer in putting the original amount of twist back in the strand and in placing the strand back in the rope. Splices should be of a nature that will allow ropes to be used for a long enough period so that splices may be made during periods of maintenance, clothing changes, or shutdowns.

Nylon ropes should be such that when the strands are opened up for splicing, they do not slip into an uncontrollable bundle of ends. In searching for a good splice to use on the carrier ropes, we found that all of the rope carrier suppliers give a recommended splicing arrangement for their particular type rope and all that we have used have proved to be satisfactory.

The splicing of ropes has been influenced by the fact that rope drives were used at an earlier time than the rope carriers. The fitting and splicing of these ropes is well documented and considerable literature is published. This literature shows that ropes used in rope drives should fit snugly in the groove of the pulley. This may have influenced the paper mill people to use smaller grooves than should be used for rope carriers, causing considerable wear both on the rope and the rope sheaves used.

A final point in the rope carrier practice is the matter of lubrication of the rope sheaves. Some manufacturers are now furnishing rope sheaves with "sealed-for-life" bearings. Their life should run 3 or 4 years, after which they are lubricated with a hypodermic needle through a neoprene shield that is built into the bearing.

‡ F. Crossman, "Nylon Sheahan Carrier Ropes," *Paper Maker* (London), March, 1951.

Received March 15, 1960. Presented at the 45th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 22–25, 1960.

Determination of Pentosans in Chemical Wood Pulps

I. GROBELNY and W. ILLUKOWICZ

The orcinol method and several variations of the bromination method for the determination of pentosans were compared using seven pulps, xylose, and pure furfural. The data show that the orcinol method is the most precise. Room-temperature bromination after double distillation with 13% HCl is recommended for mill control analyses.

In this investigation three methods for the determination of pentosans in chemical wood pulps were compared: (1) distillation with 13% HCl and determination of the furfural by bromination at room temperature, (2) distillation with 20% HBr and determination of the furfural by bromination at room temperature, and (3) distillation with 3.85 *N* HCl and determination of the furfural by the orcinol method. The objective was to select the best method for routine control work.

In the evaluation of these methods the following items were considered: (1) precision and the reproducibility of results, (2) time necessary for the performance of the determination, (3) cost of analysis, and (4) apparatus requirements (simplicity of design).

In order to evaluate the precision of individual methods, determinations were made of the furfural content of distillates obtained from the distillation of known amounts of

I. Grobelny and W. Illukowicz, Chemists, Polish Pulp and Paper Research Institute, Łódź, Poland.

xylose and furfural. Subsequently, the furfural content of the distillates from the several wood pulps was determined.

MATERIALS

The following wood pulps, ranging from 1 to 17% pentosans, were used in this study:

1. Acetate-grade sulfite, spruce, bleached (ICCA no. 2).
2. Rayon-grade sulfite, birch, bleached.
3. Rayon-grade sulfite, beech, bleached.
4. Paper-grade sulfite, spruce, bleached.
5. Greaseproof-grade sulfite, spruce, bleached (ICCA no. 8).
6. Greaseproof-grade sulfite, spruce, unbleached.
7. Semichemical pulp, beech.

EXPERIMENTAL

Bromination According to Jenke (1)

In this method the hydrolysis of pentosans and distillation with 13% HCl is carried out. The furfural in the distillate is oxidized with potassium bromate-bromide solution. The excess of bromate is determined by addition of crystalline potassium iodide and back-titrating the liberated iodine with sodium thiosulfate solution, using starch as an indicator. The chief modifications introduced by Jenke consist of: (1) a discontinuation of the neutralization of that part of the distillate which is used for the titration, (2) ceasing the use of ammonium molybdate as a catalyst, and (3) discontinuation of the refrigeration to 0 to 5°C. of the titration solution.

Two variations of Jenke method were studied: (1) a single, and (2) a double distillation. The aim of the double distillation was to obtain a solution totally free from the methylfurfural and the hydroxymethylfurfural.

Bromination According to Jayme and Sarten (2)

In this method distillation with hydrobromic acid prevents the simultaneous distillation of the hydroxymethyl- and methylfurfural, in which case the second distillation is superfluous.

The furfural content of the distillate was determined in the same way as in Jenke's method.

Colorimetric Determination According to Swedish Method CCA 24:57 (3)

In this method the distillation is carried out with 3.85 *N* HCl. The furfural content of the distillates was determined colorimetrically by use of orcinol solution, with which the

Table I. Results of Determinations of Pentosans in Chemical Wood Pulps

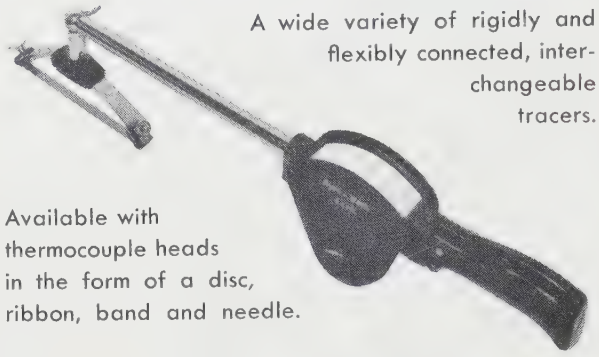
The results are reported as a percentage of furfural content[a]

Pulp no.	Kind of pulp	Bromination method: After distillation with HCl, Single	Bromination method: After distillation with HCl, Double	Bromination method: After distn. with HBr	Colorimetric (orcinol) method
1	Acetate-grade sulfite, spruce, bleached (ICCA no. 2)	1.37	0.71		0.82
		1.38	0.73		0.82
		1.37	0.73		0.84
		1.51	0.74		0.85
		1.37	0.74		0.85
		1.26	0.74		0.87
	Average	1.38	0.73		0.84
	Standard deviation	0.073	0.011		0.018
	Coefficient of variation	5.29	1.51		2.12
2	Rayon-grade sulfite, birch, bleached	3.12	2.24		2.69
		3.22	2.27		2.69
		3.25	2.27		2.70
		3.16	2.28		2.71
		3.17	2.30		2.71
		3.33	2.32		2.71
	Average	3.21	2.28		2.70
	Standard deviation	0.069	0.025		0.009
	Coefficient of variation	2.15	1.10		0.34
3	Rayon-grade sulfite, beech, bleached	3.45	2.48	3.90	2.68
		3.48	2.52	3.92	2.69
		3.53	2.53	4.00	2.71
		3.52	2.55	4.01	2.77
		3.52	2.56	4.02	2.78
		3.57	2.56	4.12	2.78
	Average	3.51	2.53	4.00	2.74
	Standard deviation	0.038	0.028	0.072	0.043
	Coefficient of variation	1.08	1.11	1.80	1.57
4	Paper-grade sulfite, spruce, bleached	4.21	2.89	3.81	3.26
		3.85	2.94	3.83	3.28
		4.15	2.98	4.04	3.29
		4.08	3.06	4.07	3.29
		3.88	3.07	4.12	3.29
		4.16	3.08	4.28	3.30
	Average	4.06	3.00	4.03	3.29
	Standard deviation	0.140	0.072	0.163	0.014
	Coefficient of variation	3.45	2.40	4.05	0.41
5	Greaseproof-grade sulfite, spruce, bleached (ICCA no. 8)	4.20	3.16		3.63
		4.02	3.16		3.65
		4.19	3.19		3.68
		4.09	3.19		3.69
		4.27	3.25		3.71
		4.00	3.27		3.78
	Average	4.13	3.20		3.69
	Standard deviation	0.100	0.042		0.048
	Coefficient of variation	2.42	1.31		1.30
6	Greaseproof-grade sulfite, spruce, unbleached	4.52	3.43	4.23	3.49
		4.84	3.47	4.25	3.51
		4.38	3.51	4.26	3.59
		4.27	3.51	4.48	3.62
		4.94	3.54	4.55	3.66
		4.90	3.55	4.65	3.68
	Average	4.64	3.50	4.40	3.59
	Standard deviation	0.263	0.041	0.165	0.071
	Coefficient of variation	5.67	1.17	3.75	1.98
7	Semichemical pulp, beech	10.78	9.20	10.77	11.03
		11.14	9.21	10.99	11.08
		11.43	9.25	11.18	11.10
		11.29	9.29	11.20	11.10
		11.12	9.32	11.31	11.13
		11.18	9.45	11.37	11.17
	Average	11.16	9.29	11.14	11.10
	Standard deviation	0.199	0.085	0.203	0.043
	Coefficient of variation	1.78	0.90	1.82	0.39
	d(+)-Xylose	57.04	53.83	55.51	59.70
		57.07	54.53	56.37	60.15
		57.36	54.82	56.77	60.23
		57.46	54.88	56.95	60.44
		57.66	55.00	57.10	61.30
		57.76	55.24	57.25	61.64
	Average	57.39	54.72	56.66	60.58
	Standard deviation	0.271	0.450	0.584	0.672
	Coefficient of variation	0.47	0.82	1.03	1.12
	Furfural	101.55	97.08	93.55	95.84
		101.55	97.08	94.00	96.17
		101.55	97.08	94.00	98.37
		101.87	97.08	94.68	98.48
		101.87	97.08	94.68	100.84
		101.87	97.40	94.68	101.17
	Average	101.71	97.13	94.27	98.48
	Standard deviation	0.051	0.119	0.441	2.046
	Coefficient of variation	0.05	0.12	0.47	2.08

[a] In converting furfural values to pentosans content the factor 1.375 was applied, and to pentose (xylose), 1.56 (3).

SURFACE CONTACT PYROMETERS

for the Paper Industry



A wide variety of rigidly and flexibly connected, interchangeable tracers.

Available with thermocouple heads in the form of a disc, ribbon, band and needle.

for temperatures up to 1800°F.

• *accurate* • *handy* • *quick response*

Used by the paper industry throughout the world, for over 30 years.

EPIC INC.

150 Nassau St.
New York 38, N. Y.
Digby 9-2470

furfural forms a colored complex. The color intensity is dependent upon many factors, such as temperature, addition of ferric chloride, acidity, ratio of the orcinol to furfural, and time of observation. Therefore, directions must be followed very closely.

The absorbancy determinations were made by use of a Lange colorimeter according to the differential method (two cells). Before starting the determinations of pentosans in wood pulp, a calibration curve for the Lange colorimeter was prepared relating absorbancy to furfural content.

RESULTS AND DISCUSSION

On the basis of the results given in Table I, it was found that the average value of the coefficient of variation for the wood pulps tested is lowest in the case of furfural determination, according to the colorimetric method (orcinol) and averages 1.26%. A slightly higher value for the coefficient of variation (1.60%) was obtained when the furfural was determined according to the bromination method after double distillation with hydrochloric acid. The results of determinations of furfural in individual wood pulps according to the colorimetric method, are essentially in agreement with those obtained according to the bromination method after double distillation with hydrochloric acid.

It should be observed that the results of determinations after single and double distillation do not agree; the average coefficient of variation in the bromination method after double distillation with hydrochloric acid is about half that obtained after single distillation.

The highest precision is obtained in the colorimetric method in which it is possible to recover, on an average, 98.5% of the furfural and 94.5% of the xylose (which corresponds to 60.6% conversion of xylose to furfural).

CONCLUSIONS

The results of the above determinations allow us to draw several conclusions:

1. Methods of determinations of pentosans in pulps are rather arbitrary. Although the precision of these methods can be determined on standard substances, such as xylose or furfural, the differences in results obtained by different methods show that conditions of hydrolysis and distillation (nature and concentration of hydrolyzing agent, time, temperature, type of apparatus, rate of distillation) influence the results to a great extent.

2. The most accurate, and simultaneously, reproducible results were obtained with the colorimetric (orcinol) method; the average value of the coefficient of variation for this method is 1.26%, and the recovery of xylose and furfural is also highest. Very good reproducibility of results was obtained when the bromination method was applied after double distillation with hydrochloric acid (coefficient of variation, 1.16%); however, the recovery of xylose and furfural was lower. The greatest variation in the results occurred with the bromination method after distillation with hydrobromic acid (coefficient of variation, 2.15%). In this method the recovery of xylose was quite good, but the recovery of furfural was low.

3. The cost of one determination and time necessary for the analysis are as follow:

Method	*Cost of one determination, zł*[a]	*Time, hr.*
Bromination and HCl	6.0	9.0
Bromination and HBr	11.0	7.0
Orcinol	19.5	9.5

[a] 100 zł = $0.85 (6 May, 1960).

4. In our opinion, the most suitable method of pentosans determination for mill control is the bromination method, after double distillation with 13% HCl. The procedure is simple, the apparatus is not complicated, the reagents are easy to obtain, and results can be accepted as satisfactory. The method is not expensive.

5. The orcinol method can be recommended for research work; it gives the most precise results, and the effect of side reactions on the result is, to a great extent, eliminated. The disadvantages of the colorimetric method are: the necessity of possession of a photocolorimeter, the use of concentrated hydrochloric acid, the low stability of orcinol in hydrochloric acid and the relatively high cost of analysis.

6. It should be noted that satisfactory results were obtained in the case of pulps with high pentosans content with the bromination method, after distillation with hydrobromic acid only. Disadvantages of this method are the difficulty of determination of small amounts of pentosans, and foaming and carryover during the distillation.

LITERATURE CITED

1. Jenke, R., *Das Papier* 6, 415 (1952).
2. Jayme, G. and Sarten, P., *Biochem. Zeitschrift* 310, 1 (1941).
3. Swedish Method CCA 24–57, "Colorimetric determination of pentosans in pulp."

RECEIVED March 15, 1960.

This paper is a condensation of a report to the ICCA. Pentosans Subcommittee.

The authors wish to express their sincere appreciation to William K. Wilson, National Bureau of Standards, Washington D.C., for his advice and encouragement to publish this paper.

Fourteenth
Alkaline Pulping Conference

Multnomah Hotel, Portland, Ore.
Aug. 22–24, 1960

INDEX TO ADVERTISERS

Abbé Engineering Co.
Aetna Standard Div. (Blaw-Knox Co.)
Air Reduction Chemical Co.
Albany Felt Co. ..... 28 A
Allegany Instrument Co., Inc. ..... 105 A
Allied Chemical Corp.
General Div.
National Aniline Div. ..... 39 A
Nitrogen Div.
Semet-Solvay Div. ..... 17 A
Solvay Process Div. ..... 33 A
Allis Co., The Louis M.
Allis-Chalmers Mfg. Co.
Aluminium Limited Sales, Inc.
Amerace Corp. (Am. Hard Rubber Co. Div.)
Amercoat Corp.
American Bitumels Co.
American Brass Co.
American Cyanamid Co. (Calcoflour)
American Cyanamid Co. (Dyestuff Dept.)
American Cyanamid Co. (Organic Chemical)
American Cyanamid Co. (Paper Chemical Dept.) ..... 41 A
American Cyanamid Co. (Pigments Div.). 49 A
American Defibrator Co.
American Hard Rubber Co.
American Key Products, Inc.
American Marietta
American Potash & Chemical Corp.
American S F Products
Anglo Paper Products, Ltd. ..... 54 A
Anheuser-Busch, Inc. (Corn Products Div.)
Ansul Chemical Co.
Antara Chemicals
Appleton Machine Co.
Appleton Wire Works, Inc... 21 A
Appleton Woolen Mills
Arabol Mfg. Co., The
Armstrong Machine Co.
Arnold, Hoffman & Co., Inc.
Asten-Hill Mfg. Co.
Atlantic Refining Co. ..... 12 A

Babcock & Wilcox Co., The (Boiler Div.) ..... 101 A
Babcock & Wilcox Co., The (Tubular Products Div.)
Bailey Meter Co.
Bauer Bros. Co., The ..... 34 A
B & B (Lodding Eng. Corp.)
Becco Chemical Div. (Food Machy. & Chemical Corp.)
Beckman Instruments, Inc.
Beloit Eastern Corp. ..... 50 A
Beloit Iron Works 29 A, 30 A
Benzing Bros. & Denney
Betz Laboratories, Inc.
Bird Machine Co. ..... 4 A
Black-Clawson Co., The ..... 11 A
Blaw Knox (Buflovak Div.)
Bolton & Sons, Inc., John W. ..... 2nd Cover
Borden Co., The (Chem. Div.) (Polyco-Monomers)
Borden Co., The (Coating & Adhesives)
Bristol Company
Brooks Rotameter Co.
Buckeye Cellulose Corp.
Buckman Laboratories, Inc.
Buckley, Dunton Pulp Co.
Bunge Pulp & Paper Co.
Burtonite Co., The

Cable Wire Co., Inc.
Cady & Co., E. J. ..... 102 A
Calgon Co. (Div. Hagan Chem. & Controls, Inc.)
Cambridge Instruments Co.
Cameron Machine Co.
Canadian Ingersoll-Rand Co., Ltd. ..... 4th Cover
Carborundum Company, The
Carpenter Steel Co. (Alloy Tube Div.)
Carthage Machine Co.
Castle & Overton, Inc.
Catalin Corp. of America
Celgar, Ltd.
Cellulose Sales Co., Inc.
Central Soya Co. (Chemurgy Div.) ..... 1 A
Chain Belt Co.
Chemipulp Process, Inc. ..... 201 A
Cheney Bigelow Wire Works
Chicago Bridge & Iron Co.
Chromium Corp. of America
Ciba Company, Inc.
Cities Service Oil Co.
Clark-Aiken Co., The
Cleary Corp., W. A.
Cleveland Crane & Eng. (Tramrail Div.
Clinton Corn Processing Co.
Colton Chemical Co. (Div. of Air Reduction Co., Inc.)
Columbia-Southern Chemical Corp.
Combustion Engineering, Inc.
Commercial Solvents Corp.
Corn Products Sales Co.
Corning Glass Works (Plant Equipment)
Crane Packing Co.
Crawford Fitting Co.
Crosby Chemicals, Inc.
Crucible Steel Co. of America
Curtiss Wright
Custom Scientific Instruments, Inc.

Darling & Co.
De la Rosa Corp.
Dexter Chemical Co. ..... 16 A
DeZurik Corp.
Diamond Alkali Co.
Diamond Power Specialty Corp.
Dicalite Div., (Great Lakes Carbon Co.)
Dixon Chemical & Research, Inc.
Dominion Eng. Co., Ltd. ..... 8 A
Dorr-Oliver, Inc.
Dow Chemical Co., The ..... 13 A
Dow Chemical Co., The (Coating Sales Dept.)
Dowell, Inc.
Draper Bros. Co.
Dravco Corp.
Dryden Paper Co., Ltd.
du Pont de Nemours & Co., Inc., E. I. (Dyestuffs) ... 59 A, 60 A
du Pont de Nemours & Co., Inc., E. I. (Electrochemicals ..... 52 A, 53 A
du Pont de Nemours & Co., Inc., E. I. (Grasselli)
du Pont de Nemours & Co., Inc., E. I. (Pigments) ... 76 A, 77 A
du Pont de Nemours & Co., Inc., E. I. (Vinyls)

Earl Paint Co.
Eastwood-Neally Corp.
Eaton Mfg. Co. (Dynamatic Div.) ..... 40 A
Ebasco Services, Inc.
Egan & Co., Frank W. ..... 22 A
Eimco Corp., The ..... 3rd Cover
Electric Controller & Mfg. Co. (Div. Square D Co.) ..... 67 A
Electric Eye Equipment Co. ..... 135 A
Electric Machinery Mfg. Co.
Electric Reduction Sales Co., Ltd.
Electric Steel Foundary Co.
Elliott Corp.
Endura Corp.
Epic, Inc. ..... 246 A

Fabri-Valve Co. of America
Farrell-Birmingham Co.
Federal Machy. & Mfg. Co., Ltd.
Felker Bros. Mfg. Co.
Ferguson Co., The H. K. ..... 250 A
Fisher & Porter, Inc.
Fitzgibbon Boiler Co.
Food Machinery & Chemical Corp. (Chlor-Alkali Div.) ..... 27 A
Fosfatbolaget
Foxboro Co., The ..... 48 A

INDEX TO ADVERTISERS

Freeport Sulphur Co.
Fuller Co.

Gardner Laboratory, Inc.
Gaspesia Sulphite Co., Ltd. . . . . 54 A
Geigy Chemical Corp.
General Chemical Co. (Allied Chemical Corp.)
General Dyestuff Co. (General Aniline & Film Corp.)
General Electric Co.
General Filter Co.
General Mills, Inc.
General Tire & Rubber Co. (Chemical Div.) . . . . . 31 A
Georgia Kaolin Co.
Gilbert Associates, Inc. . . . . 250 A
Gilbert & Nash Div. (Appleton Machine Co.)
Glidden Co., The (Chemicals-Pigments-Metals Div.)
Goodyear Tire & Rubber Co., Inc. (Chem. Div.) . . . . . 9 A
Goslin-Brmingham Mfg. Co., Inc.
Gottesman & Co.
Goulds Pumps, Inc. . . . . 47 A
Grace & Co., W. R.
Graver Tank & Mfg. Co., Inc.
Gurley, W. & L. E.

Hagan Chemicals & Controls, Inc. (Calgon Co. Div.)
Hanchett Mfg. Co.
Hansborg & Co.
Hart Products Corp.
Hauser-Stander Tank Co.
Heppenstall Company
Hercules Powder Co.
Hermann Manufacturing Co.
Hillside Laboratory . . . . . 10 A
Hoad & Associates, Inc. John G. . . . . 250 A
Hodag Chemical Corp.
Holyoke Machine Co. . . . . 107 A
Hooker Chemical Corp.
Houghton & Co., E. F.
Howard Publishing Co.
Huber Corp., J. M. (Ind. Products Div.)
Hubinger Co., The
Huffman-Wolfe, Southern Co., The
Huntington Rubber Mills, Inc.
Husky Products Co., Inc.
Huyck Felt Co.

Improved Machinery, Inc. . . . . 78 A
Industrial Nucleonics Corp.
Industrial Shredder & Cutter Co.
Infilco, Inc.
Ingersoll-Rand Co. . . . . 43 A
Inglis Co., Ltd., John
Instron Manufacturing Co.
Instrument Development Laboratories, Inc. . . . . 201 A
Inta-Roto Machine Co., Inc. . . . . 38 A
Interchemical Corp.
International Nickel Co., Inc. (Huntington Div.)
International Paper Co. (Bagpak Div.)

Jackson & Moreland, Inc. . . . . 250 A
Jagenberg-Werke A./G.
Jefferson Chemical Co.
Jefferson Lake Sulphur Co.
Jeffrey Mfg. Co.
Jenssen Co., Inc., G. D. . . . . 250 A
Johns-Manville Corp. (Celite)
Johns-Manville Corp. (Transite) . . . . . 91 A
Johnson & Co., Inc., Alvin H. . . . . 250 A
Johnson Corp., The . . . . . 102 A
Jones Corp., E. D. . . . . 64 A, 65 A

Kalle, AB
Keever Starch Co. . . . . 51 A
Kelco, The . . . . . 23 A
Kellogg Co., The, M. W. . . . . 35 A
Kinetic Dispension Corp.
Knox Woolen Co.
Koppers Co., Inc. (Ind. Gas Cleaning)
Koppers Co., Inc. (Plastic Div.) . . . . . 57 A

La Motte Chem. Products Co.
Langston Co., Samuel M.
Lahoff Grain Co.
Lawrence Pumps, Inc.
Lawson Co., The
Levey Co., Inc., Frederic H.
Lindsay Wire Weaving Co.
Link-Belt Co.
Lockwood Greene, Engineers . . . . . 250 A
Lodding Engineering Corp.
L. O. F. Glass Fibers Co.
Lummus Co., The . . . . . 250 A
Lunkenheimer Co., The
Lyon Machinery Builders

Macbeth Daylighting Corp.
Mangus Chemical Co., Inc.
Main, Inc., Chas. T. . . . . 250 A
Mallory-Sharon Metal Corp.
Manchester Machine Co.
Manhattan Rubber Div.
Mason, Neilan Regulator Co.
Mead Pulp Sales, Inc.
Meincke & Sons, Inc., A. M.
Merritt-Chapman & Scott Corp.
Metal & Thermit Corp.
Metalsalts Corp. (Metasol Div.) . . . . . 19 A
Milton Roy Co.
Minerals & Chemicals Corp. of America (Edgar Div.)
Minneapolis-Honeywell Regulator Co.
Mississippi Lime Co.
Mixing Equipment Co., Inc. . . . . 25 A
Monsanto Chemical Co. (Plastics Div.) . . . . . 46 A
Moor & Munger
Moore & White Co., The
Morden Machines Co.
Morningstar-Paisley, Inc.
Mount Hope Machinery Co.
Mount Vernon Mills, Inc. (Turner-Halsey Co.) . . . . . 2 A
Murray Manufacturing Co., D. J. . . . . 109 A

Nalco Chemical Co. . . . . 61 A
Nash Engineering Co. . . . . 105 A
National Aniline Div. (Allied Chemical Corp.)
National Forge & Ordnance Co.
National Starch & Chem. Corp.
Neofilm Div. (Great Lakes Carbon Co.)
Neville Chemical Co.
New England Lime Co.
New Jersey Zinc Co. . . . . 89 A
Newport News Shipbuilding Co.
Nichols Engineering & Research Corp.
Noble and Wood Machine Co.
Nooter Corp.
Nopco Chemical Co. . . . . 3 A
Northeastern Paper Sales, Inc. . . . . 54 A
Norton Company

O'Donoghue & Co., Roderick . . . . . 250 A
Ohio Blow Pipe Co. . . . . 140 A
Ohio Injector Co.

Please mention *Tappi* when writing to Advertisers

INDEX TO ADVERTISERS

Ohmart Corp., The ..... 107 A
Olin-Mathieson Chemical Corp. (Industrial Chem. Div.)
Orr Felt & Blanket Co., The
Owens Corning Fiberglas Corp.

Paper & Paper Products
Paper & Pulp Testing Lab. ..... 250 A
Paper Mills News
Parsons & Whittemore/Lyddon Organization
Patton Mfg. Co., Inc.
Peabody Engineering Co.
Penick & Ford, Ltd., Inc. ..... 63 A
Pennsylvania Chem. Corp.
Pennsalt Chemicals Corp.
Perkins & Sons, Inc., B. F.
Pfaudler Co., Div. (Pfaudler-Permutit, Inc.) ..... 58 A
Pfeifer & Shultz ..... 250 A
Philadelphia Quartz Co.
Photovolt Corp.
Pope & Evans ..... 250 A
Post Machinery Co.
Pratt Co., Henry ..... 20 A
Prior Chemical Corp.
Pritchard & Co., J. F.
Pyroxylin Products, Inc.

Raybestos-Manhattan, Inc. ..... 42 A
Rayonier, Inc.
Red Jacket Co., Inc.
Red-Ray Mfg. Co., Inc.
Reichold Chemicals, Inc.
Reliance Electric & Engineering Co. ..... 55 A
Republic Flow Meter Co.
Research-Cottrell, Inc.
Rhoads & Sons, J. E.
Rhodia, Inc. (Alamask Div.)
Rice Barton Corp. ..... 74 A
Riegel Paper Corp.
Riley Stoker Co.
Robbins Instrument Co., Inc.
Rohm & Haas Co. (Resinous Products Div.) ..... 69 A, 93 A
Roots-Connersville Blower Div. (Dresser Industries)
Rosenbald Corp.
Ross Engineering Co., J. O.
Ross Midwest Fulton Corp.
Rust Engineering Co.

Sandoz Chemical Co.
Sandusky Foundry & Machines Co.
Sandy Hill Iron & Brass Works
Scapa Dryers, Inc.
Scott Testers, Inc.
Semet-Solvay Div. (Allied Chemical Corp.) ..... 17 A
Shawinigan Resins Corp. ..... 75 A
Sheffield Corp., The (Bendix Aviation Corp.)
Shell Chemical Corp.
Shuler & Benninghofen Co. ..... 62 A
Simmonds Saw & Steel Corp.
Simons Worden White Co.
Simplex Wire & Cable Co.
Sinclair Co.
Sinclair & Valentine Co.
Sirrene Co., J. E. ..... 250 A
SKF Industries, Inc.
Smidth & Co., F. L.
Smith Corp., A. O.
Socony-Mobile Oil Co.
Southern Clays, Inc.
Southern Pulp & Paper Manufacturer (magazine)
Southworth Machine Co.
Spencer Chemical Co.
Sprout, Waldron & Co., Inc. ..... 68 A
Square D Co. ..... 67 A
S & S Corrugated Machinery Co.
Staley Mfg. Co., A. E. ..... 66 A
Stebbins Engineering & Mfg. Co. ..... 95 A
Stein, Hall & Co., Inc.
Stevens, Inc., Charles R.
Stickle Steam Specialties Co. ..... 111 A
St. Lawrence Starch Co.
St. Regis Paper Co.
Standard Oil Co. (Indiana)
Stone & Webster Engineering Corp.
Stowe-Woodward, Inc.
Summer Chem. Co.
Sunday & Associates, George M.
Swenson Evaporator Co.

Tanatex Chemical Corp. ..... 99 A
Taylor Instruments Cos. ..... 44 A, 45 A
Taylor Wharton Co. (Div. Harsco Corp.)
Tennessee Corp. ..... 18 A
Testing Machines, Inc.
Texas Gulf Sulphur Co.
Thiele Kaolin Co.
Thwing-Albert Instrument Co. ..... 223 A
Tidewater Construction Corp.
Tidland Machine Co.
Titanium Pigment Corp. ..... 71 A
Torrington Co., The (Bantam Bearing Div.)
Traylor Engineering & Manufacturing Co.
Tyler Co., W. S.

Union Screen Plate Co. of Canada
Union Starch & Refining Co.
United Eng. & F'dry Co.
United States Movidyn Corp.
U. S. Industrial Chemicals Co. (Div. Nat'l Distillers & Chem. Corp.) ..... 72 A, 73 A
U. S. Rubber (Naugatuck Chem. Div.) ..... 36 A, 37 A
U. S. Stoneware Co.

Valley Iron Works Co.
Vanderbilt Co., Inc., R. T. ..... 15 A
Van der Korput
Vineland Chemical Co. ..... 56 A
Virginia Smelting Co. (Industrial Div.)

Waldron-Hartig Div. (Midland-Ross Corp.) ..... 79 A–86 A
Wallace & Tiernan, Incorporated ..... 132 A
Wallerstein Co., Div. (Baxter Lab., Inc.) ..... 103 A
Wallingford Steel Co., The
Walworth Co.
Waterbury & Sons Co., H.
West End Chemical Co. (Div. Stauffer Chem. Co.) ..... 97 A
Western Precipitation Div. (Joy Mfg. Co.
Westinghouse Electric Co.
Weyerhaeuser Co.
Wheeler Mfg. Co., C. H.
Whittaker, Clark & Daniels, Inc.
Wica Chemical Co.
Weigand Co., Edwin L.
Wilco Machine Works, Inc.
Williams Apparatus Co., Inc.
Wisconsin Wire Works
Witco Chemicals Co.
Wolverine Equipment Co. ..... 110 A
Wyandotte Chemical Corp. (Michigan Alkali Div.)

Youngstown Miller Corp. ..... 113 A

Zeiss, Inc., Carl

Please mention *Tappi* when writing to Advertisers

GUIDE TO PROFESSIONAL SERVICES

THE H. K. FERGUSON COMPANY

A Subsidiary of Morrison-Knudson Company, Inc.

Engineering-Design • Construction • Installation • Plant Start-Up

PULP & PAPER MILLS — CHEMICAL PLANTS — POWER PLANTS — LABORATORIES — ATOMIC ENERGY PLANTS

Main Office: Cleveland, Ohio

Other Offices: New York • San Francisco • London • Paris

THE LUMMUS COMPANY

for over half a century
Engineers and Constructors
for Industry
PULP AND PAPER MILL DIVISION
design, construction, reports, consultation

Newark, Houston, Washington, D. C., Montreal, London, Paris, The Hague, Madrid

GILBERT ASSOCIATES, INC.

Engineers and Consultants

• Generation, Distribution and Application of Steam and Electric Power • Waste Treatment • Water and Sanitary Facilities • Studies and Reports • Plans and Specifications • Supervision of Construction

New York, N. Y. Reading, Pa. Washington, D. C.

CHAS. T. MAIN, INC.

ENGINEERS

Process Studies, Design, Specifications and Construction Supervision

PULP AND PAPER MILLS

Steam Hydraulic and Electrical Engineering
Reports, Consultation and Valuations

80 Federal Street
Boston 10, Mass.

129 West Trade Street
Charlotte, N. C.

Complete professional engineering services
for the pulp and paper industry

JOHN G. HOAD & ASSOCIATES, INC.

Consulting Engineers

YPSILANTI, MICHIGAN

RODERICK O'DONOGHUE & COMPANY

CONSULTING ENGINEERS TO THE PULP AND PAPER INDUSTRY

IMPROVED PROCESSES—DESIGNS—REPORTS

420 Lexington Ave. New York 17, N. Y.

JACKSON & MORELAND, INC.
JACKSON & MORELAND INTERNATIONAL, INC.

Engineers and Consultants

Electrical—Mechanical—Structural
Design and Supervision of Construction For Utility, Industrial and Atomic Projects
Surveys—Appraisals—Reports
Machine Design—Technical Publications

BOSTON — WASHINGTON — NEW YORK

PAPER AND PULP TESTING LABORATORIES

118 East 28 Street

New York 16, N. Y.

Certified Pulp Testers William Landes, B.S., Pulp and Paper

G. D. JENSSEN CO., INC.

49½ Maple St., P.O. Box 366, Massena, N. Y.

SULPHITE MILL ACID PLANTS—SEMICHEMICAL LIQUOR PLANTS
Sulfur Burning Plants • Jenssen Two Tower Acid Systems • Gas Coolers—Surface and Spray Type • Jenssen Pressure Acid Systems • Jenssen Auxiliary Process Towers • Recovery Plants—Cooking Acid
SOLUBLE BASE ACID PLANTS •
JENSSEN SO_2 ABSORPTION SYSTEMS
Sulfurous Acid Preparation for Bleach Plant Application
West Coast Representative—JAMES BRINKLEY COMPANY
417—9th Avenue South—Seattle, Washington

PFEIFER & SHULTZ...Engineers

Steam Power Plant Specialists

- Mills and Industrial Buildings
- Reports
- Plans and Specifications
- Supervision of Construction

Wesley Temple Bldg. Minneapolis 3, Minn.

ALVIN H. JOHNSON & CO., INC.

415 LEXINGTON AVENUE NEW YORK 17, N. Y.

CONSULTING AND DESIGNING ENGINEERS

Serving the Pulp & Paper Industries Since 1929

Telephone MUrray Hill 7-8764

POPE & EVANS

Consulting Engineers

Surveys Reports Design
relating to the
Generation, Distribution and Utilization
of
Steam and Electric Power

Main Office: 21 East 40th Street, New York 16, N. Y.

LOCKWOOD GREENE, Engineers

Est. 1832

Plant Location • Site Studies • Paper • Pulp Mills • Mill Expansion • Water • Waste • Steam-Electric Power and Utilization • Reports • Appraisals

New York 17, N. Y.
41 East 42nd Street

Spartanburg, S. C.
Montgomery Bldg.

Boston 16, Mass.
316 Stuart Street

J. E. SIRRINE CO. Engineers

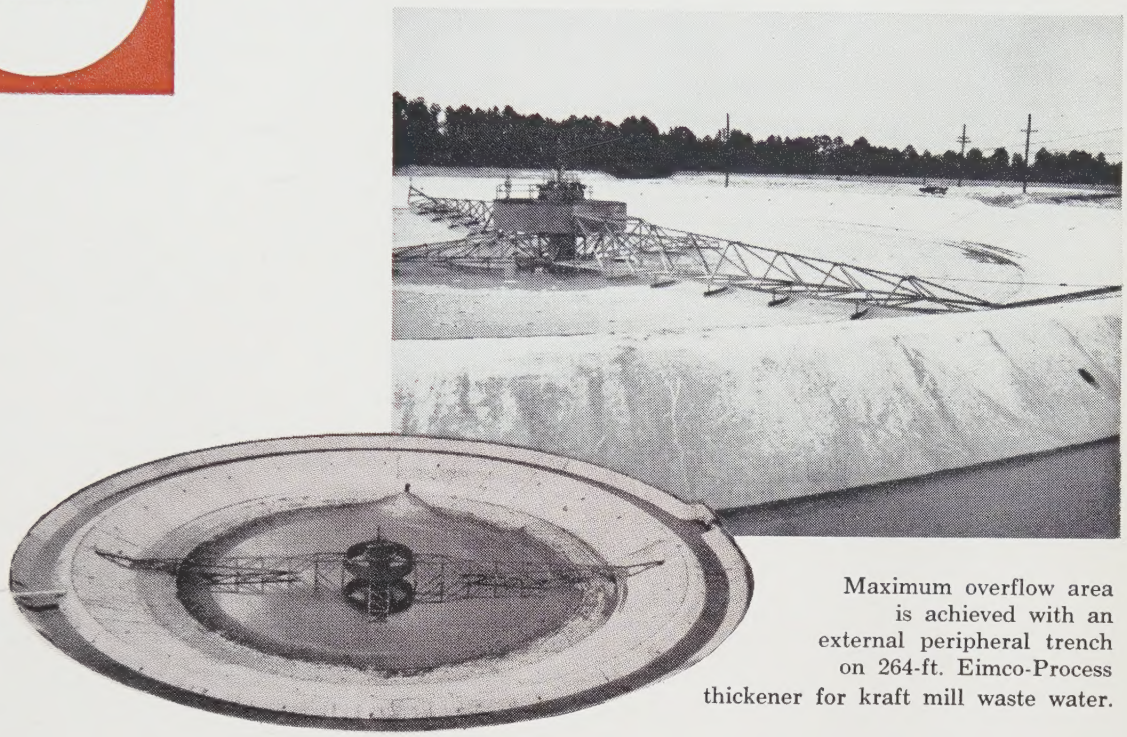
Greenville, S. C.

Est. 1902

Paper • Pulp Mills • Waste Disposal • Textile Mills • Appraisals • Water Plans • Steam Utilization • Steam Power Plant • Hydro-Electric • Reports

Protecting your water resources

EIMCO-PROCESS THICKENERS



Maximum overflow area is achieved with an external peripheral trench on 264-ft. Eimco-Process thickener for kraft mill waste water.

Shallow center depth in thickener is key to low-cost handling of pulp mill waste water.

A Southern pulp mill wanted to know if a thickener could be designed with an extremely shallow center depth and still have enough bottom slope to handle 28 MGD of kraft mill waste water.

High ground water conditions in the area would have made excavation and tank costs for a standard thickener installation excessively high.

Specialists from Eimco's Process Engineers Division and the consulting engineers went to work on the problem. A new and unusual thickener, 264 feet in diameter with special structural modifications, was designed and built.

Arm trusses were designed to permit the feedwell to extend down into the truss structure, for minimum center depth. Extra-heavy-duty drivehead and raking mechanisms were built for a torque of 800,000 ft. lb.

In operation, the special Eimco - Process thickener achieves suspended solids reductions of up to 91% at 26.8 MGD . . . providing a maximum of clarification capacity per dollar of installed cost.

The ability to furnish custom-built equipment for specific requirements is one of several ways Eimco helps pulp and paper men get better results in processing.

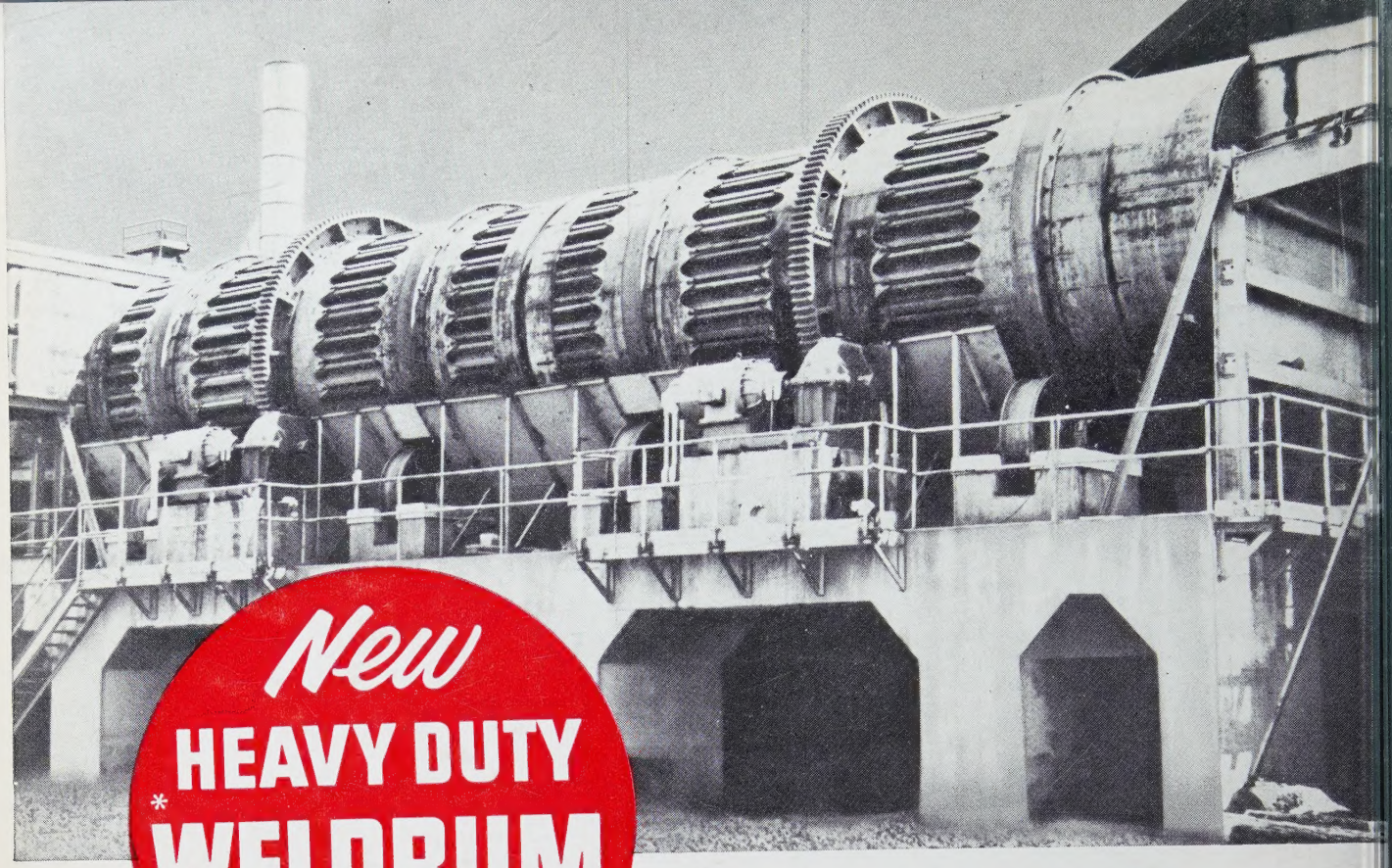
The Eimco representative in your area is a skilled specialist in equipment for liquid-solids separation. He'll be glad to sit down with you and your engineers and discuss ways to cut processing costs in your operation.

THE EIMCO CORPORATION

B-629

Process Engineers Division

420 Peninsular Avenue,
San Mateo, California



New HEAVY DUTY *WELDRUM BARKER

BUILT TO BARK MORE WOO

Faster — Cleaner — At Less Cost Per Co

The Weldrum Barker is the answer to your ever increasi demands for higher production at the lowest cost per co This new barking drum represents 50 years of experien in design, manufacture, and application by Canadi Ingersoll-Rand.

Many satisfied users report high production figures a one user says that he is getting "wood—clean as a whistl

For specific information and detailed estimates, conta your nearest Ingersoll-Rand Office, or ask for a copy of t booklet "The Weldrum Barker" by writing to Canadi Ingersoll-Rand Co. Limited, Pulp & Paper Divisio 620 Cathcart Street, Montreal 1, Canada.

Specialists in Design, Manufacture, and Application of Barking Drums.

OTHER C-I-R PRODUCTS FOR THE PULP AND PAPER INDUSTRY

MOBILE LOG BARKERS
BIRD CENTRISCREEN PRESSURE SCREENS
BIRD CYCLEANS
BIRD VIBROTOR SCREENS
JONSSON KNOTTER SCREENS
HAUG REFINERS AND DRAINERS
HAUG KOLLERMILLS
VICKERY DOCTORS
BIRD SAVE-ALLS
DIRTECS
VICKERY CONDITIONERS
PUMPS
COMPRESSORS
PNEUMATIC TOOLS

C-I-R EXPERIENCE IS YOUR WARRANTY

ST. JOHN'S
MONCTON
MONTREAL
TORONTO
SUDBURY
KIRKLAND LAKE
WINNIPEG
CALGARY
VANCOUVER

IR CANADA

*TRADE MARK REGISTERED

Canadian Ingersoll-Rand Co. Limited

HEAD OFFICE: MONTREAL, QUE. WORKS: SHERBROOKE, QUE

O-129-A